Ex-Post Project Evaluation 2021: PackageIII-4 (Mauritius, Nigeria, Malawi)

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Republic of Mauritius

FY2021 Ex-Post Evaluation Report of Japanese Grant Aid Project

"The Project for Improvement of Meteorological Radar System (I) (II)"

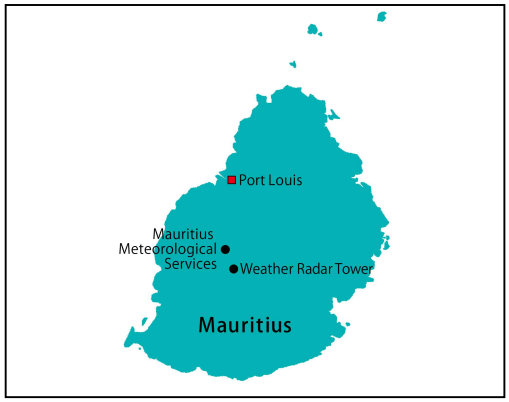
External Evaluator: Koichiro Ishimori, Value Frontier Co., Ltd

0. Summary

The project was intended to strengthen the monitoring capability of meteorological phenomena, such as cyclones, by developing a meteorological radar system in Mauritius, thereby contributing to reducing the damage from natural disasters. The relevance of the project corresponds to all three perspectives of coherence: 1) development policies, 2) development needs, and 3) appropriateness of the project plan and approach. Regarding coherence, it is confirmed that the project is 1) coherent with the development cooperation policies of Japan, and 2) aligned with the JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024) as an internal coherence. It is also confirmed as an external coherence that the project is 3) coherent with the policy of the U.N. World Conference on Disaster Risk Reduction. Therefore, its relevance and coherence are high. The efficiency of the project is moderately low because the project cost is assumed to have slightly exceeded the planned cost, and the project period significantly exceeded the planned period. Regarding effectiveness, the actual values achieved the target values for all quantitative indicators, and some of them surpassed the target values. Capacity-building activities supported the realization of quantitative effects. Regarding impacts, Mauritius Meteorological Services (MMS) is now able to swiftly provide precise weather information because of the project, which enables the National Disaster Risk Reduction and Management Centre (NDRRMC) and media to swiftly provide precise weather information for the people. Moreover, the provision of weather information helps the people and workers in the tourism sector to take emergency measures against disaster damage. Additionally, the implementations of the project and JICA's other technical cooperation projects in Mauritius have not only fostered momentum to establish but actually established "Disaster Risk Reduction Management Platform" targeting Southwest Indian Ocean and Southeast African regions, and the activities are now conducted at the platform on an even larger scale than when it was established. Since regional activities tackling regional issues are beyond what the original plan expected, the effectiveness and impacts of the project are very high. Although there is a slight issue in the institutional/organizational aspect of the operation and maintenance of the project, it is highly likely to be resolved. Therefore, the sustainability of the project effects is high.

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

1. Project Description



Project Locations
(source: External Evaluator)

Meteorological radar tower
(source: External Evaluator)

1.1 Background

Mauritius is an island country located in the Southwest Indian Ocean, where cyclones occur frequently, and is vulnerable to natural disasters, such as rainstorms, high tides, floods, and landslides caused by cyclones. Before the project was implemented, Mauritius's tourism industry, enjoying a rich natural environment, shared approximately 17%[1] of the GDP and employed approximately 17%[2] of the working population. Its agriculture sector strongly affected by nature shared only approximately 3%[3] of the GDP and employed approximately 7%[4] of the working population. Therefore, cyclones significantly affected the economy. Under such circumstances, there were concerns that global warming in recent years would intensify the forces of cyclones and that the damage caused by natural disasters would become more severe than ever. Therefore, developing appropriate countermeasures against disasters, such as cyclones, was a pressing agenda in Mauritius.

1.2 Project Outline

The objective of this project is to strengthen the monitoring capability of meteorological phenomena, such as cyclones, by developing a meteorological radar system in Mauritius, thereby contributing to reducing the damage from natural disasters.

<Grant Aid Project>

Grant Limit / Actual Grant Amount	(I) 1,079 million yen, 1,150 million yen (modified) / 1,150 million yen (II) 190 million yen / 190 million yen

[1] https://www.statista.com/statistics/1262269/contribution-of-travel-and-tourism-to-gdp-in-mauritius/
[2] https://www.statista.com/statistics/1262276/share-of-employment-in-travel-and-tourism-in-mauritius/
[3] https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=MU
[4] https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=MU

Exchange of Notes Date /Grant Agreement Date	June 2013, December 2013 (the 1st modification), November 2015 (the 2nd modification), March 2018 (the 3rd modification) / June 2013, December 2013 (the 1st modification), November 2015 (the 2nd modification), March 2018 (the 3rd modification)
Executing Agency	Mauritius Meteorological Services (MMS)
Project Completion	March 2019
Target Areas	Vacoas (MMS HQs) Trou aux Cerfs (Meteorological radar tower site)
Main Contractors	Joint venture of Marubeni Corporation and Shimizu Corporation
Main Consultants	Joint venture of International Meteorological Consultant Inc. and Japan Weather Association
Preparatory Survey	October 2011 – August 2012
Related Projects	JICA "the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024)"

2. Outline of the Evaluation Study

2.1 External Evaluator

Koichiro Ishimori, Value Frontier Co., Ltd

2.2 Duration of Evaluation Study

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

Duration of the Study: October, 2021 – November, 2022

Duration of the Field Study: January 17, 2022 – January 28, 2022, April 9, 2022 – April 14, 2022

3. Results of the Evaluation (Overall Rating: A[5])

3.1 Relevance/Coherence (Rating: ③[6])

3.1. 1. Relevance (Rating:③)

3.1.1.1 Consistency with the Development Plan of Mauritius

The national development plan at the time of ex-ante evaluation, "*Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing Countries (2005)*," mentioned strengthening the early warning capability of meteorological phenomena, such as cyclones, to reduce damage caused by natural disasters, and so did "*Mauritius Strategy for Implementation -National Assessment Report 2010- (2010).*" Furthermore, the sector plan, "*A Climate Change Action Plan (1998)*," referred to the importance of the roles to be played by Mauritius Meteorological Services (MMS), together with the importance of data collection in response to climate change, development of basic documents for

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

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

monitoring, assessment of vulnerabilities and risks, and development of capabilities and technologies.

The national development plan at the time of ex-post evaluation, "*Mauritius Vision 2030 - Innovative and Globally Competitive- (2017)*," attempts to shift the country's industrial structures from the primary industry to the secondary and tertiary industries, especially financial, information and communication, and tourism industries. Although the plan does not mention strengthening the early warning capability of meteorological phenomena, it is indispensable to promote the tourism industry enjoying a rich natural environment, such as the development of beach resorts. Furthermore, the sector plan, "*Update of the Nationally Determined Contribution of the Republic of Mauritius (2021)*" updated from "*Intended Nationally Determined Contribution for the Republic of Mauritius (2015)*," mentions the importance of the MMS swiftly providing precise weather information to continuously respond to climate change.

In sum, since the project was intended to strengthen the monitoring capability of meteorological phenomena, such as cyclones, at the MMS, it is consistent with the development policies of Mauritius both at the time of ex-ante and ex-post evaluation.

3.1.1.2 Consistency with the Development Needs of Mauritius

In Mauritius, the meteorological radar system, which was installed with support from the United Nations Development Programme (UNDP), began observations in 1979. However, it stopped its operation owing to damage by Cyclone Dina in 2002 and termination of spare parts provision by makers. Since then, the MMS had no choice but to rely on low-resolution satellite images by the meteorological satellite METEOSAT which the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) was operating, and radar images with limited monitoring areas by the meteorological radar that neighboring French territory Réunion was operating to monitor natural phenomena, such as cyclones. Consequently, it was unable to swiftly provide precise weather information for the entire country.

According to the MMS statistics at the time of ex-post evaluation, the total number of cyclones that occurred from 1981 to 2000 in Southwest Indian Ocean where Mauritius is located was 67, that is, 3.35 on average per year. However, it became 102 for the next 20 years from 2001 to 2020, that is, 5.1 on average per year, which is an increasing trend. Especially for the recent three years from 2018 to 2020, it was 24, that is, eight on average per year. This average is almost double that over the past 40 years. Global warming increases the seawater temperature, and the higher the seawater temperature, the stronger the updraft. Since this results in intensifying the forces of cyclones, it is expected that damage by cyclones will become more severe in the future. Therefore, swift provisions of precise weather information are important not only for the safety of the people but also for tourism and agriculture that depend on nature.

In sum, since the project was intended to strengthen the monitoring capability of meteorological

phenomena by developing a high-resolution meteorological radar system with wide monitoring areas at the MMS, it is consistent with the development needs of Mauritius, both at the time of ex-ante and ex-post evaluation.

3.1.1.3 Appropriateness of the Project Plan and Approach

The ex-post evaluations of similar projects in the past indicated the importance of developing capabilities for radar analyses by weather forecasters and electric facility management by engineers through capacity-building activities. Therefore, the project also conducted capacity-building activities, including the same content, and brought about the realization of effects. Thus, the project plan was considered appropriate.

3.1.2 Coherence (Rating:③)

3.1.2.1 Consistency with Japan's ODA Policy

Yokohama Action Plan (2008) of *the 4th Tokyo International Conference on African Development (TICAD)* emphasized "developing an early warning system" as one of its five priorities, "Addressing Environmental/Climate Change issues." Additionally, the summary by the chair of TICAD IV indicated "the necessity of giving appropriate attention to the specific needs of Small Island Developing States." Therefore, *the Project Plan (2012)* of *the Country Assistance Policy for Mauritius* prioritized cooperation programs related to "environment, climate change, and disaster prevention."

The project was intended to develop an early warning system for meteorological phenomena, such as cyclones, as part of the measures for climate change in an island country that *Yokohama Action Plan (2008)* emphasized. Therefore, it was coherent with Japan's development policies at the time of ex-ante evaluation.

3.1.2.2 Internal Coherence

No JICA project was implemented before ex-ante evaluation of the project.

The JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024), which is being implemented at the time of ex-post evaluation, has been assisting the MMS in issuing different warnings depending on areas by using the high-resolution meteorological radar system with wide monitoring areas that the project developed. Therefore, it is trying to help the MMS staff to improve their capabilities for meteorological monitoring and early warnings. However, the technical cooperation project has been experiencing delays owing to the spread of COVID-19. Consequently, it has not yet realized any expected outcomes and synergies through collaboration with the project, for example, the MMS issuing different warnings depending on areas. Nevertheless, both the project and the technical cooperation project are intended to improve the

monitoring capability of meteorological phenomena at the MMS and collaborate with each other to reduce damage caused by natural disasters. Thus, internal coherence is confirmed at the time of ex-post evaluation.

3.1.2.3 External Coherence

Hyogo Framework for Action (2005) of *the 2nd U.N. World Conference on Disaster Risk Reduction (WCDRR)* that was designated at the time of ex-ante evaluation emphasized "Developing early warning systems that are people centered, in particular systems whose warnings are timely and understandable to those at risk" in one of its five priorities, "identify, assess, and monitor disaster risks and enhance early warning."

Sendai Framework for Disaster Risk Reduction (2015) of *the 3rd WCDRR* that was designated at the time of ex-post evaluation emphasized "promoting real-time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and enhance the collection, analysis and dissemination of data" in one of its four priorities, "Understanding disaster risk."

In sum, the project is aligned with priorities emphasized by *Hyogo Framework for Action (2005)* and *Sendai Framework for Disaster Risk Reduction (2015)* of the WCDRR. Thus, external coherence is confirmed at the time of ex-ante and ex-post evaluation.

In conclusion, regarding relevance of the project, the project responds to three perspectives: 1) relevance to the development plan, 2) relevance to the development needs, and 3) appropriateness of the project plan and approach. Regarding coherence, coherence with TICAD and the country assistance policy is recognized as coherent with Japan's development assistance policy. Regarding internal coherence, JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024), is recognized as collaboration with the project. However, no outcomes or synergies have yet been realized through concrete collaboration with the project. Additionally, regarding external coherence, the project is recognized as coherent with the WCDRR policy. However, no outcomes or synergies have yet been realized through concrete collaboration with the project. Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The physical outputs of the project were realized as planned.

Table 1: Planned and actual outputs

	Planned outputs		Actual outputs	
	MMS HQs	Observatory	MMS HQs	Observatory
Facilities				
Meteorological radar tower	—	1	—	As planned
Equipment				
Meteorological radar system	—	1 set	—	As planned
Meteorological radar data display system	1 set	1 set	As planned	As planned
Meteorological data communication system	1 set	1 set	As planned	As planned

Source: Materials provided by JICA and MMS

The original outputs from capacity-building activities were technical assistance related to 1) to 3) only in Table 2. However, technical assistance related to 4) to 9) was also added to the activities based on the request from the MMS and its necessity.

Table 2: Planned and actual outputs from the capacity-building activities

	Planned outputs	Actual outputs
1) Meteorological radar check-ups, fault finding, remedy and recovery	1.3MM	As planned
2) Meteorological operation and maintenance	1.3MM	As planned
3) Meteorological radar observation	1.0MM	As planned
4) Basic knowledge on meteorological radar	—	0.2MM
5) Reflection of meteorological radar product into weather forecast operation	—	0.5MM
6) Meteorological data communication system operation, check-ups, fault finding, remedy and recovery	—	0.1MM
7) Power backup system operation, check-ups, fault finding, remedy and recovery	—	0.1MM
8) Meteorological radar management techniques using measuring instruments	—	0.3MM
9) Web server fault finding, and releasing meteorological radar product in the web site	—	0.1MM
Total	3.6MM	4.9MM

Source: Materials provided by JICA and MMS

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost on the Japanese side was 1,079 million yen, and that on the Mauritian side was 191 million yen; thus, the planned total project cost was 1,270 million yen.

However, the actual project cost on the Japanese side was expected to exceed the grant limit of 1,079 million yen owing to the sharp depreciation of the yen. Therefore, the project was divided into two phases. Nevertheless, Phase I resulted in 1,150 million yen, and Phase II in 190 million yen. Thus, the actual project cost on the Japanese side was 1,340 million yen, 261 million yen higher than the grant limit[7]. However, it was an appropriate response because all the constructed

[7] Owing to the sharp depreciation of the yen (79.89 yen per U.S. dollar at the time of the cabinet meeting in March 2013 to 99.43 yen per U.S. dollar at the time of the cabinet meeting in October 2013), the construction cost of facilities was expected to increase. Therefore, in December 2013, the project cost on the Japanese side was increased at the 1st amendment of E/N and G/A to 1,150 million yen (facility: 451 million yen, equipment: 583 million yen, design and supervision: 115 million yen). Although the total project cost on the Japanese side was 1,149 million yen, the amended

facilities and procured equipment that the project had planned were indispensable for realizing the project effects. Meanwhile, details of the project cost on the Mauritian side were missing in many items, and thus, the precise amount was unknown. However, the valued added tax, the largest expenditure item on the Mauritian side, was approximately 19 million Mauritian Rupees (MUR) and was less than planned. Therefore, even if the actual cost of missing items was to some extent higher than the planned cost, it was assumed that the actual project cost on the Mauritian side would be less than the planned cost of 191 million yen.

In sum, while the actual project cost on the Japanese side was higher than planned, it is assumed that the actual project cost on the Mauritian side was within the planned cost. Therefore, it is assumed that the actual total project cost on both sides was less than 1,531 million yen (1,340 million yen on the Japanese side and 191 million yen on the Mauritian side) and was higher than 100% and lower than 125% of the planned total project cost. As it is assumed to have slightly exceeded the plan, efficiency of the project cost is evaluated to be high.

Table 3: Planned and actual project cost

	Planned cost	Actual cost
Total project cost	1,270 million yen	1,478 million yen
Project cost on the Japanese side	1,079 million yen[8] Construction of facilities：385 million yen Procurement of equipment：578 million yen Design and supervision：115 million yen	1,340 million yen (I) 678 million yen (II) 0 million yen (I) 380 million yen (II) 162 million yen (I) 92 million yen (II) 28 million yen
Project cost on the Mauritian side	191 million yen (≒MUR 67,729,538[9]) Connection of electricity to the new meteorological radar tower: MUR 583,338 Connection of water to the new meteorological radar tower: MUR 102,000 Connection of telephone to the new meteorological radar tower: MUR 30,000 Connection of internet to the new meteorological radar tower: MUR 48,000 Value added tax: MUR 60,000,000 Dismantle of the existing meteorological radar tower: MUR 252,000 Clearance of the existing meteorological observation system: MUR 840,000 Relocation of the existing communication line: MUR 754,200	138 million yen (≒MUR 42,836,453[10]) MUR 1,372,975 MUR 58,072 Unknown Unknown MUR 40,990548 MUR 212,458 MUR 202,400 Unknown

grant limit of E/N and G/A was made at 1,150 million yen. Furthermore, owing to the continuation of the sharp depreciation of the yen (99.43 yen per U.S. dollar at the time of the cabinet meeting in October 2013 to 119.08 yen per U.S. dollar in July 2015), the bidding of construction of facilities and procurement of equipment became unsuccessful and was retried by reducing some equipment from the scope. However, the equipment reduced from the scope were meteorological radar data display system and meteorological data communication system and were the basis of meteorological radar system. Thus, 190 million yen (equipment: 162 million yen, design and supervision: 28 million yen) was added as the phase II.

[8] The total project cost on the Japanese side was 1,078 million yen, however, the grant limit of E/N and G/A was made to be 1,079 million yen.

[9] Calculated at the exchange rate of 2.825 yen per MUR during the preparatory survey in February 2012.

[10] Recalculated at the IFS rate (annual average) from 2013 to 2019.

	Renovation of the existing security office: MUR 800,000	Unknown
	Installation of air conditioner at the existing office: MUR 200,000	Unknown
	Renovation of the existing gates, fences, lighting facilities in and around the site: MUR 4,000,000	Unknown
	Gardening: MUR 120,000	Unknown

Source: Materials provided by JICA and MMS

3.2.2.2 Project Period

While the planned project period was 23 months from June 2013 (signing G/A) to April 2015, the actual project period was 70 months from June 2013 (signing G/A) to March 2019, which was 304% of the planned period. Since the actual project period significantly exceeded the planned period, efficiency of the project period is evaluated to be low.

Table 4: Reasons for delays

Period	Reasons for delays
From G/A to Detailed Design (D/D)	The sharp depreciation of the yen necessitated recalculation of the project cost and the following amendment of the grant limit of E/N and G/A, resulting in 6 months of delay.
D/D (including bidding period)	The successful applicant of the 1st bidding received suspension measures of participating in the bidding for another project and lost the qualification for participating in the bidding of the project. The successful applicant of the 2nd bidding declined the bidding owing to the sharp depreciation of the yen. These resulted in 22 months of delay in D/D including bidding period.
Construction	Preparation for construction and design change of piling work owing to finding of cavity under the ground resulted in 19.5 months of delay.

Source: Materials provided by JICA and MMS

In conclusion, while the efficiency of the project cost is high, the efficiency of the project period is low. Therefore, the efficiency of the project is moderately low.

3.3 Effectiveness and Impacts[11] (Rating: ④)

3.3.1 Effectiveness

Since the project was intended to strengthen the monitoring capability of meteorological phenomena, such as cyclones, the external evaluator analyzed in the following quantitative and qualitative effects what has been strengthened and the method adopted for that.

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

[11] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 5: Quantitative effects (operation and effect indicators)

Indicator	Baseline values 2012	Target value 3 years after completion 2022	Actual value Year of completion 2019	Actual value 1 year after completion 2020	Actual value 2 years after completion 2021	Actual value 3 years after completion 2022
1) Wind direction/ speed and rainfall intensity	-	Within a radius of 200 km (Observation of wind speed up to 75 m/s maximum)	Within a radius of 200 km (Observation of wind speed up to 233 m/s maximum)			
		Within a radius of 450 km (Detection of rainfall whose intensity is more than 1 mm/h)	Within a radius of 450 km (Detection of rainfall whose intensity is more than 1 mm/h)			
2) Spatial resolution and observation interval of rainfall data	Only main island of Mauritius; 9.85 km mesh; 30 mins interval	Within a radius of 450 km; 2.5 km mesh; 10 mins interval	Within a radius of 450 km; 2.5 km mesh; 10 mins interval			
3) Observation interval of image on location and route of cyclone	15-30 mins interval (METEOSAT)	1 min interval (PPI mode)10 mins interval (CAPPI mode)	30 seconds interval (PPI mode) 10 mins interval (CAPPI mode)			
4) Observation of disturbance and wind shear by meteorological radar system	Impossible (Visual observation only)	Within a radius of 200 km	Within a radius of 200 km			
5) Provision of information via internet on disturbance and wind shear for the int'l airport	-	Possible	Possible			
6) Short-term prediction on trends of rain clouds	-	1-2 hours	1-2 hours			
7) Identification of areas with more than 100 mm of rainfalls within 12 hours	-	Possible (based on specified time cumulative rainfall data)	Possible (based on specified time cumulative rainfall data)			

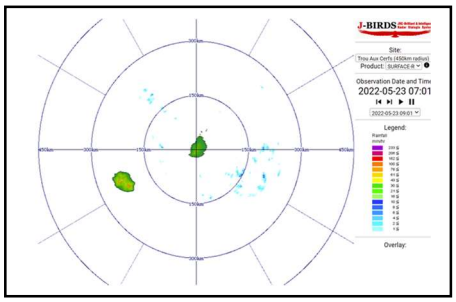
* The actual values above are the values that the project has been achieving since the completion of the project until the time of ex-post evaluation.
Source: Materials provided by JICA and MMS

1) Wind direction/speed and rainfall intensity

Before the project, there were no means of measuring wind direction/speed and rainfall intensity. After the project, as long as the wind speed is up to 233 m/s, surpassing the target value of 75 m/s maximum, it became possible to observe the area within a radius of 200 km. Additionally, as long as the rainfall intensity is more than 1 mm/h, as planned, it becomes possible to observe the area within a radius of 450 km.

2) Spatial resolution and observation interval of rainfall data

Before the project, the MMS observed rainfall data by rain gauges installed on the island. Therefore, the observation areas were limited to the areas where they were installed. Additionally, the

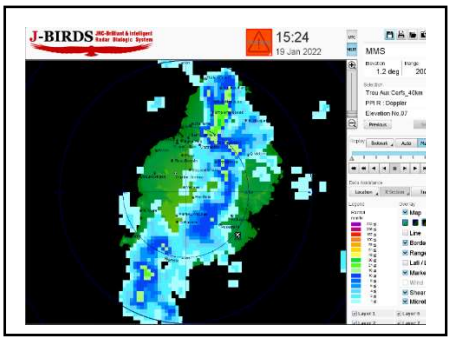


Radar Image

observation was made in 9.85 km mesh and in every 30 minutes. After the project, the observation areas are stretched as planned to a radius of 450 km, centered around Mauritius, and the observation is made in a 2.5 km mesh and every 10 minutes.

3) Observation interval of image on location and route of cyclones

Before the project, the MMS observed location and route of cyclones using low-resolution satellite images with 15 to 30 minutes interval by the METEOSAT that the EUMETSAT was operating. After the project, PPI mode[12] allows the MMS to observe them with 30 seconds interval, surpassing the target values of 1 minute interval, as the right image, and CAPPI mode[13] allows the MMS to observe them with 10 minutes interval as planned.



PPI Mode Image

4) Observation of disturbances[14] and wind shear[15] by the meteorological radar system

Before the project, the MMS was unable to observe disturbances and wind shear using the meteorological radar system. After the project, it is possible to observe them within a radius of 200 km, as planned.

5) Provision of information via internet on disturbances and wind shear for the international airport

Before the project, the MMS was unable to provide information on disturbances and wind shear for the international airport. After the project, it is possible to do it as planned. The MMS provides information for the airport four hours before all aircrafts that are expected to depart or arrive.

6) Short-term prediction on rain cloud trends

Before the project, the MMS was unable to make a short-term prediction of rain cloud trends. After the project, it is possible to make a prediction one to two hours ahead, as planned.

7) Identification of areas with more than 100 mm of rainfall within 12 hours

Before the project, the MMS was unable to identify areas with more than 100 mm of rainfall within 12 hours. After the project, it is possible, as planned.

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[12] PPI stands for Plan Position Indicator and is a mode to collect high-altitude data by making a radar rotate 360 degrees at a certain elevation angle.
[13] CAPPI stands for Constant Altitude Plan Position Indicator and is a mode to collect a certain altitude data by making a radar rotate 360 degrees at multiple elevation angles.
[14] Disturbance is a relatively small atmospheric turbulence that changes in real time.
[15] Wind shear is a rapid variation in direction or wind speed between two different points in either vertical or horizontal direction in the atmosphere.

In sum, the project has been achieving the target values in all operation and effect indicators from the year 2019, the year of completion, to 2022, the time of ex-post evaluation. Especially, the actual values of indicators 1) and 3) surpassed the target values. Therefore, it can be said that the monitoring capability of meteorological phenomena has been strengthened to a greater extent than in the originally planned project.

3.3.1.2 Qualitative Effects (Other Effects)

Capacity-building activities 1) to 4) and 6) to 8) out of 1) to 9) are technical assistance related to the operation and maintenance of the meteorological radar system, all of which have supported the achievement of the quantitative effects 1) to 4) and 6) to 7). Capacity-building activities 5) and 9) provide technical assistance related to processing and releasing meteorological radar information, both of which have been supporting the achievement of the quantitative effect 5).

The ex-ante evaluation sheet indicated as qualitative effects improvement in the awareness of disaster prevention, implementation of early evaluation, and reduction of human and economic losses. However, to achieve these goals, it is necessary to conduct awareness activities on disaster prevention and evacuation drills at schools and offices. Since the project did not include any such activities, the external evaluator did not analyze the qualitative effects indicated in the ex-ante evaluation sheet[16].

3.3.2 Impacts

This project was intended to contribute to reducing the damage caused by natural disasters. Therefore, the external evaluator analyzed the contributions and the method adopted in the following qualitative impacts.

3.3.2.1 Intended Impacts

1) Enabling precise and swift issuance of alerts through swift provision of precise weather information.

Before the project, the MMS issued warnings based on rainfall data collected every 30 minutes by rain gauges installed at 21 locations on the island. Therefore, it was neither possible to collect precise weather information in areas without rain gauges nor issue swift alerts. However, with the meteorological radar system by the project, the MMS is now able to collect precise weather information and swiftly provide them for the National Disaster Risk Reduction and Management Centre (NDRRMC). Consequently, NDRRMC can also issue precise and swift alerts.

The JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024) is intended to set different warning

[16] There are problems with the indicator settings, the external evaluator does not put a negative consideration on them because they do not affect the project per se.

standards depending on the four regions into which Mauritius is divided, and to enable the MMS to issue more precise warnings. However, as mentioned before, the technical cooperation project has been experiencing delays owing to the spread of COVID-19. Consequently, no impact has yet been realized through collaboration with the project at the time of ex-post evaluation.

2) Enabling avoidance of unnecessary outing and reinforcement of such facilities as houses, in advance through provision of information on the forces and expected routes of cyclones via media.

Before the project, the MMS had no choice but to rely on low-resolution satellite images by the METEOSAT and radar images with limited monitoring areas by the meteorological radar that neighboring French territory Réunion was operating to collect information on the forces and routes of cyclones. However, with the meteorological radar system by the project, the MMS can precisely collect information on cyclones within a radius of 450 km. Consequently, it is now able to provide such information to all its stakeholders and public through its own homepage, and broadcasts and newspaper articles by media with which the MMS collaborates, including the national television and radio station. Additionally, the MMS issues four levels of cyclone warnings in scale, and the NDRRMC coordinates operations with the entities that have the power to give directions depending on the level, including shutting down schools and government offices. Consequently, they help the people to take emergency measures against disaster damage[17].

3) Enabling tourism and agricultural workers take early measures against disasters through provision of swift and precise weather information.

Using the meteorological radar system by the project, the MMS can swiftly collect precise weather information. Consequently, the MMS is now able to swiftly provide it for tourism workers through the Tourism Board with which the MMS collaborates. As cited in the article below, the provision of such information helps tourism workers to take emergency measures against disasters. Meanwhile, it seems that agricultural workers do not take any emergency measures against such disasters such as cyclones because there are hardly any such measures that they can take.

Currently, the NDRRMC is implementing a project to disseminate alerts based on cyclone warnings that the MMS issues to all the people. As of 2022, the number of cell phones registered in Mauritius is 1.9 million, which exceeds the number of its population, 1.26 million people. In theory, this means that one person has more than one cell phone. Therefore, it is planning to develop by 2025 a system to send alerts based on cyclone warnings with short mail to the people with cell phones and smartphones.

[17] Having received information on cyclones, Mauritian people were taking emergency measures against disasters to the extent possible even before the project. Therefore, it should be noted that it does not necessarily mean that the project has made it possible for the people to do them.

  According to the staff working at Mauritian Wildlife Foundation that provides marine transport services to Ile aux Aigrettes designated as a natural protected area, it takes such emergency measures against disasters as putting its owned ships on land when it receives cyclone warnings from the Tourism Board for which MMS provides weather information. According to a travel agency that provides diving tour services and others, it also takes the same emergency measures.	 According to the farm owner producing sugarcane that is a major agricultural product in Mauritius, there are hardly any emergency measures against cyclones that he can take, and thus he cannot do any.

3.3.2.2 Other Positive and Negative Impacts

The project was classified as Category C because it was not in the sectors that were prone to have negative effects indicated in the JICA Guidelines for the Confirmation of Environmental and Social Consideration (April 2010).

1) Impacts on the Natural Environment

The Ministry of Environment and Sustainable Development exempted the project from environmental impact assessment based on the Environment Protection Act (2002). The Ministry of Health and Quality of Life gave the MMS a health permit under the following conditions, and the MMS satisfied all the conditions.

I. Connecting water supply to the building of meteorological radar tower;

II. Installing appropriate drainages at the building of meteorological radar tower;

III. Obtaining a permit from the Wastewater Management Board on the collection and disposal of wastewater drained from the building of a meteorological radar tower;

IV. Appropriate collection and disposal of wastes generated from the building of a meteorological radar tower;

V. Controlling noises coming from devices inside the building of meteorological radar tower under the level that the Environment Protection Act (2002) designates; and

VI. Keeping appropriate light and ventilation inside the building of meteorological radar tower.

2) Resettlement and Land Acquisition

There was no resettlement or land acquisition because the meteorological radar tower had been rebuilt at the existing site.

3) Gender

The percentage of households with a television in Mauritius was 97.4% in 2012 before the

project and 98.4% in 2020[18]. In short, almost all households in Mauritius had television even before the project. Additionally, as of 2022, one Mauritian person has more than one cell phone or smartphone. In Mauritius, women can access weather information without any problems because they enjoy the freedom to watch television and have communication devices, such as smartphones. Therefore, the project had no positive or negative impact on women.

4) Minorities

As mentioned above, everybody can access weather information without any problems in Mauritius. Therefore, the project had no positive or negative impact on the socially vulnerable population.

5) Social system, norms, and well-being

None

6) Other Unintended Positive/Negative Impacts

In March 2019, Cyclone Idai hit Southeast Africa and caused disasters that affected over three million people. It was the time when the project and the JICA's technical cooperation project, The *Project* for Landslide Management, were already complete, and the JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities, was about to start. Consequently, there was a feeling of momentum in Mauritius to spread its know-how on measures against disasters to neighboring countries. Thus, in July 2019, "Disaster Risk Reduction Management Platform" comprising four countries in Southwest Indian Ocean (Mauritius, Madagascar, Comoros, and Seychelles) and three countries in Southeast Africa (Mozambique, Malawi, and Zimbabwe) was established under the leadership of JICA and the government of Mauritius. Although its activities slowed owing to the spread of COVID-19, an online workshop was held with a new member of South Africa in January 2022. In the workshop, the participating countries shared numerous forms of knowledge. The knowledge was about contributions to disaster risk reduction by the MMS, the importance of disaster risk reduction, the experience of Cyclone Idai, and the importance of disaster education. Thereafter, it discussed disaster risk reduction in South African and Indian regions. These regional activities to tackle regional issues were not included in the original plan, and thus surpassed the original plan.

The project has achieved all target values in the quantitative effects 1) to 7) of effectiveness, and some of the actual values surpassed the target values. Capacity-building activities 1) to 9) have been supporting the achievement of quantitative effects 1) to 7) and realizing qualitative effects.

[18] Statistics Mauritius, "Availability of ICT to households, 2006 – 2020"

Regarding impacts, the MMS can swiftly provide precise weather information because the project makes it possible for the NDRRMC and media to swiftly provide precise weather information for the people. Moreover, the provision of such information contributes to helping the people and tourism workers to take emergency measures against disasters. The project has not realized any impact through collaboration with JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities. However, the project and the multiple technical cooperation projects have built a feeling of momentum to establish "Disaster Risk Reduction Management Platform" in Southwest Indian Ocean and Southeast African regions and have led to its establishment. Furthermore, it now performs its activities on a larger scale than before. These regional activities to tackle regional issues were not included in the original plan, and thus surpassed the original plan. In sum, this project has achieved its objectives more than it was planned. Therefore, effectiveness and impacts of the project are very high.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and System

The National Disaster Risk Reduction and Management Policy 2020-2030 (2020) at the time of ex-post evaluation highlights the importance of continuously improving resilience against disasters in the development process of Mauritius, and considers that preparations for disasters and early warnings in many forms are indispensable to avoid or reduce the effects by disasters. According to the NDRRMC that has made the policy, 98% of those who have been affected by disasters from 1960 to 2018 are owing to cyclones. Therefore, the relevance of the project to the effects that the project has realized, that is, strengthening the monitoring capability of meteorological phenomena, such as cyclones, is continuously confirmed.

3.4.2 Institutional/Organizational Aspect

The MMS was under the umbrella of the Ministry of Defense and Internal Affairs at the time of ex-ante evaluation. Later, it came under the umbrella of the Ministry of Environment, Waste Management, and Climate Change in December 2014, and thereafter, the Ministry of Local Government and Disaster Risk Management in February 2020. However, there has been no change in the institutional and organizational aspects of the MMS. The permanent staff at the MMS increased from 115 at the time of ex-ante evaluation to 140 at the time of ex-post evaluation. Two communication engineers and seven electronic technicians in the operational meteorology department are in charge of operating and maintaining the meteorological radar system that the project developed. The planned positions of one system engineer and three other electronic technicians have not been filled. However, there is no institutional and organizational problem because the budget for filling the positions is likely to be approved in the budget of the new fiscal

year from July 2022 to June 2023.

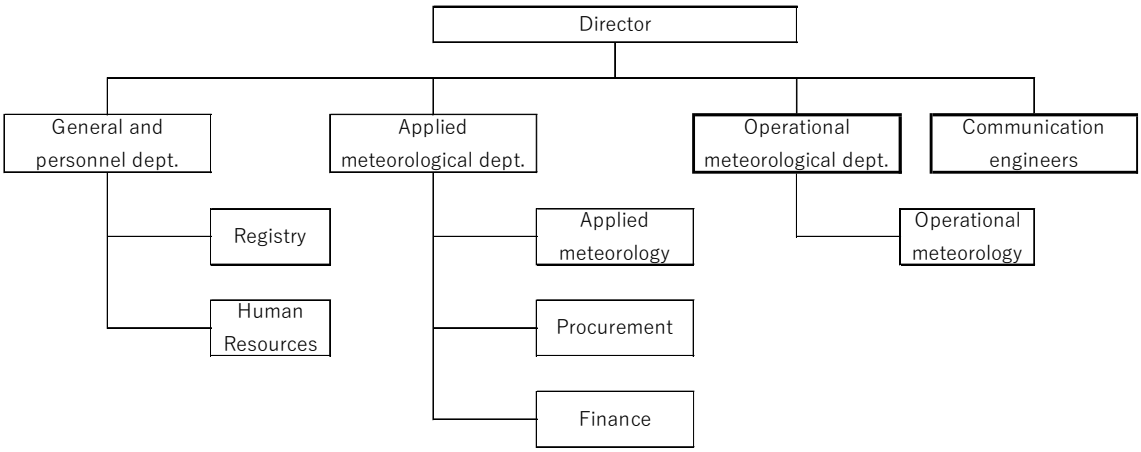


Chart 1: Organigram of the MMS

Source: Materials provided by MMS

3.4.3 Technical Aspect

Capacity-building activities have developed a routine maintenance manual (routine maintenance procedure using gauges, meteorological Doppler radar system manual, radar system maintenance book), spare parts replacement procedures (spare parts replacement and operation procedure), and fault response manual (fault finding, remedy, recovery procedure, and procedure responding to serious faults). The MMS conducts regular maintenance of each piece of equipment and provides training for its staff on the manuals in case of necessity. Additionally, since the JICA's technical cooperation, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024), continues to strengthen MMS staff members' monitoring capability of natural phenomena, it is expected that the MMS will improve its technical capability. Therefore, there is no technical problem.

3.4.4 Financial Aspect

The annual budget of the MMS decreased from 145 million Mauritian Rupees in 2019 to 116 million Mauritian Rupees in 2021 owing to the effects by COVID-19. Meanwhile, the annual operation and maintenance costs at the MMS HQs and Trou aux Cerfs observatory were almost the same as planned. However, according to the MMS, the annual operation and maintenance costs at present are sufficient to operate and maintain the meteorological radar system that the project has developed. Moreover, as described below, the facilities and equipment that the project constructed and procured are well operated and maintained. Therefore, there is no financial problem.

Table 6: The annual budget of the MMS

(Unit:1,000 MUR)

	First year of completion of the project (July 2019 －June 2020)	Second year of completion of the project (July 2020 －June 2021)	Third year of completion of the project (July 2021 －June 2022)
Total budget	145,500	109,000	116,000
Planned operation and maintenance costs	694	730	1,495
Actual operation and maintenance costs	646	772	－

Source: Materials provided by JICA and MMS

3.4.5 Environmental and Social Aspect

There was no problem with environmental and social considerations from the implementation period of the project until the time of ex-post evaluation.

3.4.6 Preventative Measures to Risk

There was no risk, such as a hit by a super cyclone, negatively affecting the achievement of the project effects from the implementation period of the project until the time of ex-post evaluation.

3.4.7 Status of Operation and Maintenance

The MMS performs daily clean-up work and security work at the meteorological radar tower and also performs regular check-ups (repairs for abrasions, damages, and deteriorations) of the meteorological radar system at the HQs and observatory. There is no problem with the operation and maintenance of facilities and equipment. Additionally, the MMS signed the agreement of "Spare Parts Supply Contract" agreement with the maker of the meteorological radar system on March 6, 2019. The contract period of supplying PC equipment that the MMS can easily procure in Mauritius is over on March 5, 2022. However, the contract period for supplying spare parts and consumables of the mainstay system is valid until March 5, 2034. Therefore, there is no problem with procurement of spare parts.

In conclusion, a slight issue has been observed in the institutional/organizational aspect. However, there are good prospects for resolution. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project was intended to strengthen the monitoring capability of meteorological phenomena, such as cyclones, by developing a meteorological radar system in Mauritius, thereby contributing

to reducing the damage from natural disasters. The relevance of the project corresponds to all three perspectives of coherence: 1) development policies, 2) development needs, and 3) appropriateness of the project plan and approach. Regarding coherence, it is confirmed that the project is 1) coherent with the development cooperation policies of Japan, and 2) aligned with the JICA's technical cooperation project, the Project for Enhancing Meteorological Observation, Weather Forecasting and Warning Capabilities (2019 – 2024) as an internal coherence. It is also confirmed as an external coherence that the project is 3) coherent with the policy of the U.N. World Conference on Disaster Risk Reduction. Therefore, its relevance and coherence are high. The efficiency of the project is moderately low because the project cost is assumed to have slightly exceeded the planned cost, and the project period significantly exceeded the planned period. Regarding effectiveness, the actual values achieved the target values for all quantitative indicators, and some of them surpassed the target values. Capacity-building activities supported the realization of quantitative effects. Regarding impacts, the MMS is now able to swiftly provide precise weather information because of the project, which enables the NDRRMC and media to swiftly provide precise weather information for the people. Moreover, the provision of weather information helps the people and workers in the tourism sector to take emergency measures against disaster damage. Additionally, the implementations of the project and JICA's other technical cooperation projects in Mauritius have not only fostered momentum to establish but actually established "Disaster Risk Reduction Management Platform" targeting Southwest Indian Ocean and Southeast African regions, and the activities are now conducted at the platform on an even larger scale than when it was established. Since regional activities tackling regional issues are beyond what the original plan expected, the effectiveness and impacts of the project are very high. Although there is a slight issue in the institutional/organizational aspect of the operation and maintenance of the project, it is highly likely to be resolved. Therefore, the sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Since April 2019, the MMS has been being able to collect and gather detailed meteorological data, which was unable before, because of the meteorological radar system that the project developed. The data could contribute not only to promoting an understanding of meteorological phenomena, such as cyclones, but also to reducing disaster damage caused by cyclones. Therefore, it is expected that the MMS should promote an understanding of meteorological phenomena, such as cyclones, by conducting research using the gathered meteorological data in collaboration with research institutions inside and outside the country.

4.2.2 Recommendations to JICA

"Disaster Risk Reduction Management Platform" comprising four countries in Southwest Indian Ocean and four countries in Southeast Africa could contribute not only to promoting an understandings of meteorological phenomena such as cyclones in the regions but to reducing disaster damage caused by cyclones. It is expected that the JICA Madagascar Office that supports activities by the platform should assist the MMS in collaborating with and establishing research teams with research institutions inside and outside the country.

4.3 Lessons Learned

Appropriate indicator settings

The ex-ante evaluation sheet indicated as qualitative effects improvement in the awareness of disaster prevention, implementation of early evaluation, and reduction of human and economic losses. However, to achieve these goals, it is necessary to conduct awareness activities on disaster prevention and evacuation drills at schools and offices. However, this project did not include any such activity. When setting indicators at the time of planning, it is important to set appropriate indicators based on the project activities.

5. Non-Score Criteria

5.1. Performance

5.1.1 Objective Perspective

JICA built cooperative relationships with the MMS through smooth communication from the time of planning to the implementation period of the project.

5.2. Additionality

Initially, the participating countries in "Disaster Risk Reduction Management Platform" were four countries in Southwest Indian Ocean (Mauritius, Madagascar, Comoros, and Seychelles) and three countries in Southeast Africa (Mozambique, Malawi, and Zimbabwe). JICA had offices in four counties, excluding Mauritius, Comoros, and Seychelles, and had networks with disaster-related ministries. In addition, it has completed or implemented disaster-related projects in Mauritius, Seychelles, and Mozambique[19]. This created a feeling of momentum to establish the platform, eventually resulting in its establishment. Without mentioning the contributions under the initiatives of the Mauritian government, the contributions made by JICA to expand the project to activities in the regions were also huge.

(End)

[19] In Mauritius, there were the JICA's technical cooperation project and the Project for Landslide Management. In Seychelles, there was the JICA's technical cooperation project, Project for the Study for Coastal Erosion and Flood Control Management. In Mozambique, there was the JICA's technical cooperation project, Project on Strengthening Resilience in Cyclone Idai-Affected Areas.

Federal Republic of Nigeria

FY2021 Ex-Post Evaluation Report of
Japanese Grant Aid Project
"The Project for Emergency Improvement of Electricity Supply Facilities in Abuja in the Federal Republic of Nigeria"

External Evaluators: Keisuke Nishikawa, Sayaka Ando, Hiroshi Nishino
Metrics Work Consultants Inc.

0. Summary

The project aimed to reduce transmission power loss and improve the power supply to the Abuja Federal Capital Territory and the surrounding area (Nasarawa State) by installing power capacitors at the Apo and Keffi Substations, thereby contributing to the promotion of economic and social development of the target area. The project was consistent with Nigeria's development policies and needs at the time of the planning and the ex-post evaluation, and the project plan and approach were appropriate based on lessons learned from similar past projects. As for the internal coherence, there was no specific coordination with other JICA projects, which was initially expected. As for the external coherence, there was some coordination with other projects through the executing agency. However, the implementation of those projects was significantly delayed, and the results of the coordination were limited. On the other hand, the consistency with Japan's ODA policy at the time of planning was observed. Therefore, its relevance and coherence are high. Although the project period slightly exceeded the plan, the project cost remained within the plan, and the efficiency of the project is high. The project increased the rate of voltage improvement in the target area, which was assumed at the time of planning, and stable and efficient power supply was realized mainly for large-scale facilities. Although some issues persist, such as unstable power supply due to the population growth in the target area, the effectiveness and impacts of the project are high, as it achieved the overall expected effects and impacts, and no negative impacts were observed. There were no organizational, technical, or financial issues in the operation and maintenance of the project, and the facilities were operating without any issues. Therefore, the sustainability of the project effects is high.

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

1. Project Description

Project Location
(source: external evaluator)

Power Capacitor Equipment installed in the Project
(source: external evaluator)

1.1 Background

Nigeria has a large number of power generation facilities in southern region where the natural gas is produced, while the northern region does not have sufficient power generation facilities. Therefore, Nigeria's central region, where Abuja Federal Capital Territory (FCT) is located, and the northern region require long-distance power transmission from the southern region, resulting in significant voltage drops, and the transmission losses are also significant. In addition, the voltage drop associated with the low proportion of dynamic reactive power (power that is not consumed as energy by only traveling back and forth between the power source and the load) has been an obstacle to a stable and quality power supply. The voltage drops were particularly severe in the capital and the surrounding areas far from power generation facilities, resulting in an unstable power supply for an average of only about eight hours per day.

As a measure to improve the situation, it was necessary to introduce phase modifiers such as power capacitors (equipment that controls dynamic reactive power to keep the system voltage constant) at substations and other power supply facilities. In the capital and the surrounding areas, it was an urgent issue to improve the facility in the Apo Substation, which is a key substation distributing power to Abuja FCT. It was also urgent for the Keffi Substation, which is an important substation as it is located in an area where the power system will be expanded in the future, and is transmitting power to substations that are planned to be newly constructed. Therefore, this project supported the installation of power capacitors at both the Apo and Keffi Substations to realize efficient and stable power supply to Abuja area.

1.2 Project Outline

The objective of this project is to reduce transmission losses and improve the reliability of power supply in the Abuja FCT and the surrounding area (Nasarawa State) by installing power capacitors, thereby contributing to the promotion of economic and social development in the area.

<Grant Aid Project>

Grant Limit / Actual Grant Amount		1,317 million yen / 1,303 million yen
Exchange of Notes Date / Grant Agreement Date		February 2016 / February 2016
Executing Agency		Responsible authority: Federal Ministry of Power (FMOP) Executing agency: Transmission Company of Nigeria (TCN)
Project Completion		August 2018
Target Area		Abuja Federal Capital Territory and the surrounding area (Nasarawa State)
Main Contractors	Consultant	Yachiyo Engineering Co., Ltd.
	Equipment Procurement	Toyota Tsusho Corporation
Basic Design / Preparatory Survey		October 2014 - November 2015
Related Projects		<Technical Cooperation> - The Project for Master Plan Study on National Power System Development in the Federal Republic of Nigeria (2015-2019) - The Project for Improving Electricity Distribution Sector Capacity in the Federal Republic of Nigeria (2022-2025) <Other International Organizations> Agence Française de Développement: Secure Power Supply in the Federal Capital (2014-2020)[1]

2. Outline of the Evaluation Study

2.1 External Evaluator

Keisuke Nishikawa, Sayaka Ando and Hiroshi Nishino, Metrics Work Consultants Inc.[2]

2.2 Duration of Evaluation Study

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

Duration of the Study: October 2021 - January 2023

Duration of the Field Study: May 7 - May 19, 2022 and October 6 - October 13, 2022

[1] Secure Power Supply in the Federal Capital, Agence Française de Développement, https://www.afd.fr/en/carte-des-projets/secure-power-supply-federal-capital (accessed November 7, 2022)

[2] Nishikawa and Ando participated as reinforcement from Qunie Corporation. Nishino was in charge of satellite data analysis, while Nishikawa and Ando were in charge of the other work (including field study).

2.3 Constraints during the Evaluation Study

None

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

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

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Nigeria

At the time of planning this project, Nigeria's national development policy, *Nigeria Vision 20: 2020* (2009-2020), called for Nigeria to become one of the top 20 economies in the world by 2020. The policy cited the need for infrastructure development in order to make strides toward further social and economic development, and a stable and inexpensive power supply was considered an important goal. The *National Implementation Plan* (2010-2013), a concrete action guideline for the policy, identified infrastructure development (electricity and transportation) as one of the top priorities.

In *Nigeria's Medium Term National Development Plan 2021-2025*, the national development plan at the time of the ex-post evaluation, one of the nine priorities is to achieve self-sufficiency in electricity and petroleum products. Specific strategies include large-scale financing to improve power generation capacity, establishing infrastructure to supply natural gas used for power generation, and upgrading the power grid.

In addition, the goals for the power sector in the above development plan include increasing transmission capacity, reducing transmission losses[5] and improving people's access to electricity[6].

Based on the above, the stable supply of electricity is of great importance in the policies in Nigeria at both the planning and ex-post evaluation stages. Since the project aims at efficient and stable power supply by expanding substation facilities, the project is consistent with Nigeria's development policy at both the time of planning and ex-post evaluation.

3.1.1.2 Consistency with the Development Needs of Nigeria

Nigeria's national peak electricity demand was 9,571 MW in 2016 at the time of planning, while peak electricity supply was 5,074 MW[7], which indicates that the electricity supply was not keeping up with the demand. When peak electricity demand was checked during the ex-

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

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

[5] In *Nigeria's Medium Term National Development Plan 2021-2025*, the indicator is the amount of energy in the national grid, with a target of 10,000 MW in 2025 (baseline is 3,592 MW).

[6] In *Nigeria's Medium Term National Development Plan 2021-2025*, the indicator is the percentage of the population with access to electricity, with a target of 75% in 2025 (baseline is 55.4%).

[7] It is the amount of electricity sent to the power grid and does not include off-grid, such as on-site power generation.

post evaluation, it had further increased year by year since 2016, reaching 15,532 MW in 2021 (about 62% increase compared to the demand in 2016). In contrast, peak electricity supply remained at 5,802 MW. Installed generation capacity increased from 2016, reaching 12,974 MW as of 2020. However, the generation capacity remained at 5,758 MW as of 2020.[8] According to the Transmission Company of Nigeria (TCN), the reason for the generation capacity being far below the installed capacity is the unstable procurement of natural gas used for power generation.[9] However, as noted above, the peak electricity demand has been increasing year after year until the time of the ex-post evaluation, and the efficient and stable power supply continues to be a challenge.

In addition, there are few power plants around Abuja FCT, and the electricity is transmitted through a long distance from the south, resulting in significant voltage drops associated with the low proportion of dynamic reactive power in Abuja and the surrounding areas. The subsequent transmission losses were also significant and the power supply was unstable, with an average of only about 8 hours per day at the time of planning the project. As a measure to improve the situation, it was necessary to introduce phase modifiers such as power capacitors at the power supply facilities such as substations. At the time of the ex-post evaluation, Abuja and the surrounding areas were still dependent on power supply from other states, and the demand for the equipment remained high.

Consequently, it can be said that the project is consistent with the development needs, since the demand for a stable power supply exists in the target area at the time of planning and ex-post evaluation, and the project plays an important role in addressing the demand.

3.1.1.3 Appropriateness of the Project Plan and Approach

In the past, the results of the ex-post evaluation of similar projects indicated that the project was delayed due to the lack of necessary budget allowance from the counterpart government. Therefore, the consultant was expected to fully explain and discuss the counterpart government's burden, and promptly confirm and follow up on the budgetary measures and the detailed schedule. This was undertaken by the implementing consultant, and there was no delay in the implementation of the project due to the delay in the budgetary measures by the counterpart government. It was also confirmed that the Nigerian side properly implemented the power outage of the connection segment during the construction period, leading to a smooth implementation of the construction work on the Japanese side. There was no significant difference between the planned and actual results, and the project was handled

[8] Installed generation capacity refers to the capacity of a power generation facility, while generation capacity refers to the actual capacity of a power generation facility based on the availability of generating fuel and other factors.

[9] Two reasons for the unstable procurement of natural gas were cited by TCN: (1) high pricing by natural gas suppliers and (2) the need for timely payment for natural gas that can be purchased with government subsidies.

based on lessons learned from similar projects in the past. Based on the above, there are no problems with the appropriateness of the project plan and approach.

3.1.2 Coherence (Rating: ②)

3.1.2.1 Consistency with Japan's ODA Policy

At the time of planning the project, Japan had identified priority areas of support for Nigeria, including core infrastructure development. Also in the "JICA Country Analysis Paper for the Federal Republic of Nigeria" (formulated in May 2015), stable electricity supply was identified as an important issue, which is consistent with Japan's ODA policy.

3.1.2.2 Internal Coherence

A related project to this project is the "The Project for Master Plan Study on National Power System Development in the Federal Republic of Nigeria (2015-2019)." According to the JICA Nigeria office, while this was not the intended coordination, data from this grant aid project was used in the development of the master plan. However, no specific outcomes were identified.

In addition, as another related project, JICA technical cooperation project for the Abuja Electricity Distribution Company (AEDC), entitled "The Project for Improving Electricity Distribution Sector Capacity in the Federal Republic of Nigeria (2022-2025)" has been initiated. The project is to provide technical assistance to AEDC in facility design, maintenance management, etc., by conducting training programs that will contribute to the reduction of power distribution losses and improvement of supply reliability. This technical cooperation project and this grant aid project have a high affinity, and synergistic effects are expected. However, this technical cooperation project just started in April 2022, and the synergistic impact was not yet achieved at the time of the ex-post evaluation.

Based on the above, although a certain degree of synergy was confirmed in the "The Project for Master Plan Study on National Power System Development in the Federal Republic of Nigeria," the synergy was identified as a result, without the specific coordination that was initially intended.

3.1.2.3 External Coherence

At the time of planning the project, the Agence Française de Développement (French Development Agency, AFD) planned to implement the related projects (e.g., construction of new transmission lines, installation of new transformers to the Apo Substation, etc), and this grant aid project was planned based on that information. Although no direct coordination or collaboration between JICA and the AFD was observed, both projects were planned under the coordination of TCN. The AFD's project consists of the enhancement of five substations etc.,

including the Apo Substation covered by this grant aid project. According to TCN, the AFD's project is generally scheduled to be completed by the end of 2022 due to delays caused by the spread of COVID-19, delays in customs clearance procedures at the port, and issues related to land and easement acquisition. After the completion of the AFD's project, it is expected that the two projects will stabilize the power supply through different approaches: the expansion of substation and transmission capacity through the AFD's project, and the improvement of facility utilization (improvement of power factor and increase of dynamic reactive power) through this grant aid project. However, no synergistic effects were identified as of the ex-post evaluation.

In addition, the government of Nigeria has been undertaking several projects for the rehabilitation and the expansion of substations and transmission lines with its own funds. Although there was no direct coordination or cooperation between these projects and this grant aid project, as with the AFD's project, there was coordination under TCN, and no overlap in the scope of support was identified.

Based on the above, the AFD's project was significantly delayed and no synergies were identified at the time of the ex-post evaluation. Although there was no direct coordination or cooperation with the projects implemented by the government of Nigeria, synergies were considered to have emerged under TCN's coordination.

The project was consistent with Nigeria's development policies and needs at the time of the planning and the ex-post evaluation, and the project plan and approach were appropriate. The project was also consistent with Japan's ODA policy at the time of planning. As for the internal coherence, there was no specific coordination with other JICA projects, which was originally assumed. As for the external coherence, though not direct, there was some coordination with other projects through TCN. However, the implementation of some of these projects had been delayed significantly and the synergistic effects were limited at the time of the ex-post evaluation.

Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

Table 1 shows the planned and actual outputs of the project, and Table 2 shows the planned and actual project items borne by the Nigerian executing agency.

Table 1: Planned and Actual Outputs from the Project

Planned	Actual
Apo 132/33 kV Substation	
1. Power capacitor facility (132 kV, 60 MVar)	Implemented as planned
2. Special high-voltage switchgear	Implemented as planned
3. Protection and control panel	Implemented as planned
4. Substation grounding equipment	Implemented as planned
5. Low-voltage equipment	Implemented as planned
6. Foundations for equipment	Implemented as planned
Keffi 132/33 kV Substation	
1. Power capacitor facility (132 kV, 25 MVar)	Implemented as planned
2. Special high-voltage switchgear	Implemented as planned
3. Protection and control panel	Implemented as planned
4. Substation grounding equipment	Implemented as planned
5. Low-voltage equipment	Implemented as planned
6. Foundations for equipment	Implemented as planned
7. Underground cable for electric power (132 kV)	Implemented as planned
8. DC power supply	Implemented as planned

Source: Information provided by JICA

Table 2: Planned and Actual Items Borne by Nigerian Executing Agency

Planned	Actual
Apo 132/33 kV Substation	
1. Renewal of transformers, switchgear, girders, lightning protection equipment, etc., damaged by lightning strike in September 2014	Implemented as planned
2. Replacement and repair of damaged control panels and related equipment in the control building	Implemented as planned
3. Project site preparation	Implemented as planned
4. Check and ensuring of the grounding resistance (1 Ω or less) of the existing grounding equipment	Implemented as planned
5. Relocation of existing lighting	Implemented as planned
6. Securing of a location for installation of control and protection panels in the existing control building	Implemented as planned
7. Provision of control power (DC and AC) for control and protection panels to be procured	Implemented as planned
Keffi 132/33 kV Substation	
1. Calibration of indicating meters such as wattmeters and reactive power meters on the 132 kV control panel in the control building of the existing transformer	Implemented as planned
2. Removal of obstructions on the project site	Implemented as planned
3. Project site preparation	Implemented as planned
4. Check and ensuring of the grounding resistance (1 Ω or less) of the existing grounding equipment	Implemented as planned
5. Relocation of existing lighting	Implemented as planned
6. Securing of a location for installation of control and protection panels in the existing control building	Implemented as planned
7. Provision of control power (AC) for control and protection panels to be procured	Implemented as planned

Source: Prepared by the evaluators based on the information provided by JICA and interviews with the executing agency

Table 1 and Table 2 show that the outputs from the project and the items borne by the Nigerian executing agency were implemented as planned.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned Japanese portion of the project cost was 1,317 million yen, while the actual cost was 1,303 million yen, which was within the plan (99% of the originally planned amount). Nigeria's share of the planned project cost was 3 million yen, while the actual cost was the same 3 million yen, which was within the plan (100% of the originally planned amount).

3.2.2.2 Project Period

The project period exceeded the plan (107% of the plan) with an actual period of 31 months compared to the planned 29 months. The construction period was extended for 3 months due to a defect in the discharge coil, a component of the power capacitor, which occurred during the acceptance test of the equipment to be installed at the Keffi Substation.[10]

The training programs were implemented for 9 weeks, compared to the planned 14 weeks. The reason for the shortened duration was that the Nigerian side was unable to secure a budget for travel and daily allowances for the training participants. Although the duration was shortened, the training was provided as originally planned through the deployment of additional personnel and the implementation of intensive classroom lectures, etc.

Based on the above, the outputs of the project were implemented as planned for both the items borne by Japan and Nigeria. Although the project period slightly exceeded the plan, the project cost was kept within the planned budget. Therefore, the efficiency of the project is high.

3.3 Effectiveness and Impacts[11] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Five operation and effect indicators were set as measures of quantitative effectiveness for the project, and the target values were set for 2021, three years after the project completion, using the values in 2014 as a baseline.[12] Table 3 shows the planned and actual comparisons of the indicators of the quantitative effectiveness.

[10] Since some training programs were implemented during the procurement and installation of materials and equipment, the extended construction period does not coincide with the extended project period.

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

[12] Although the target year was 2020 in the ex-ante evaluation paper, the analysis is based on actual results for the year 2021, as three years after the project completion is in 2021.

Table 3: Comparison of Planned and Actual Indicators of Quantitative Effectiveness

Indicator		Baseline Value	Target Value	Actual Value			
		2014	2021	2018	2019	2020	2021
(1) Voltage improvement rate at receiving end (%)	Apo Substation (132 kV incoming side)	N/A	2.9	2.95	2.94	3.06	2.9
	Apo Substation Note 1 (33 kV outgoing side)	N/A	3.01	13.44	12.79	12.6	12.73
	Keffi Substation (132 kV incoming side)	N/A	6.19	2.96	2.94	3.01	2.95
	Keffi Substation (33 kV outgoing side)	N/A	6.84	12.93	13.1	13.01	12.71
(2) Transmission loss in 132-kV transmission lines (MW/(%)) (for the area covered by the project)		N/A	101.4 (6.85)	N/A	N/A	N/A	6.05 (4.04) Note 2
(3) Reduction amount of greenhouse gas emission (t/year)		N/A	6,404	N/A	N/A	N/A	13,141 Note 2
(4) Number of households benefiting from improved supply of electricity (households/day)	Apo Substation	N/A	5,400	N/A	N/A	N/A	7,450
	Keffi Substation	N/A	1,700	N/A	N/A	N/A	1,887
(5) Number of consumers benefiting from improved supply of electricity (persons/day)	Apo Substation	N/A	24,300	N/A	N/A	N/A	33,525 Note 3
	Keffi Substation	N/A	9,350	N/A	N/A	N/A	10,379

Note 1: The improvement ratio on the 33 kV outgoing side of the Apo Substation is an average value because there are several transformers to be measured.
Note 2: Since the executing agency did not maintain actual data for (2) transmission losses, the values calculated by the evaluator were listed as estimates. The estimated values were also used to calculate (3) GHG reductions.
Note 3: As the executing agency did not have actual data on the number of households supplied at the Apo Substation, which is necessary for the calculation of the number of households supplied for the purpose of (4), the figure in the Preparatory Survey Report was used.
Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

Indicator (1) Voltage improvement rate at receiving end (%)

The voltages with and without power capacitors in operation at both substations measured at 20:00 on March 2, 2022 are shown in Table 4.

Table 4: Measured Voltages at the Apo and Keffi Substations with and without Power Capacitors in Operation

Apo Substation (132 kV incoming side):

Measured Value	Equipment to be Measured	2018	2019	2020	2021
Voltage when capacitor is in operation (kV)	132 kV Transmission line	132.8	133	128	134.8
Voltage when capacitor is not in operation (kV)		129	129.2	124.2	131

Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

Apo Substation (33 kV outgoing side):

Measured Value	Equipment to be Measured	2018	2019	2020	2021
Voltage when capacitor is in operation (kV)	132 kV/33 kV transformer 45 MVA[13] (a)	33.9	33.1	33.4	34
Voltage when capacitor is not in operation (kV)		30.1	29.3	29.6	30
Voltage when capacitor is in operation (kV)	132 kV/33 kV transformer 45 MVA (b) Note 1	33.9	N/A	N/A	N/A
Voltage when capacitor is not in operation (kV)		30.1	N/A	N/A	N/A
Voltage when capacitor is in operation (kV)	132 kV/33 kV transformer 100 MVA (a)	34	33.7	34.2	34
Voltage when capacitor is not in operation (kV)		29	29.9	30.4	30.2
Voltage when capacitor is in operation (kV)	132 kV/33 kV transformer 100 MVA (b)	34.1	33.7	34.3	34.7
Voltage when capacitor is not in operation (kV)		30.6	29.9	30.5	30.9

Note 1: There was no record since 2019, as 132 kV/33 kV transformer 45 MVA (b) has not been in operation since 2019 due to transformer breakdown caused by fire accident, and will be replaced with 100 MVA transformer by 2023.
Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

Keffi Substation (132 kV incoming side):

Measured Value	Equipment to be Measured	2018	2019	2020	2021
Voltage when capacitor is in operation (kV)	132 kV transmission line	132	133	130	132.5
Voltage when capacitor is not in operation (kV)		128.2	129.2	126.2	128.7

Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

Keffi Substation (33 kV outgoing side):

Measured Value	Equipment to be Measured	2018	2019	2020	2021
Voltage when capacitor is in operation (kV)	132 kV/33 kV transformer 30 MVA	33.2	32.8	33	33.7
Voltage when capacitor is not in operation (kV)		29.4	29.0	29.2	29.9

Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

The voltage when the capacitor is operating is compared to that when the capacitor is not operating, then the rate of increase is the voltage improvement ratio at receiving end (%) (the percentage increase is stated in Table 3 in the actual values). The voltage at receiving end on the incoming and outgoing sides of the Apo Substation and the outgoing side of the Keffi Substation

[13] MVA stands for "mega volt ampere," which is the unit of apparent power used in power equipment. The appropriate value for a 132 kV transmission line is around 132 MVA, and the one for a 132 kV/33 kV transformer is around 33 MVA, with lower values indicating low voltage conditions.

achieved the target values. Although only the incoming side of the Keffi Substation did not meet the target, the voltage was confirmed to be an appropriate value and not an issue.[14]

Based on the above, the indicator of the voltage improvement ratio at receiving end was achieved.

Indicator (2) Transmission loss in 132-kV transmission lines (MW/(%)) (for the area covered by the project)

The 132-kV transmission lines to which the power capacitors installed through the project mainly contributed are the following sections from A to E, at the time of the ex-post evaluation. The amount of power transmission with and without power capacitors in operation on these lines, and the amount and percentage of reduction in transmission losses calculated by comparing them, are shown in Table 5. Since some data was not maintained by the executing agency, estimates of the figures calculated by the evaluators are shown.

Table 5: Measured Results on a 132-kV Transmission Line with and without Power Capacitors in Operation and Transmission Losses Calculated by Comparison of the Results

132 kV Transmission Line	Amount of Electricity Transmitted (MW)		Reduction in Transmission Losses (MW)	Percentage of Reduction in Transmission Losses (%)
	Capacitor not in Operation	Capacitor in Operation		
A. Gwagwalada - Apo	30.8	32.4	1.6	4.94
B. Katampe - Apo	34.9	36.03	1.13	3.14
C. Apo - Kalu	41.46 Note 1	43.2	1.74	4.04 Note 1
D. Kalu - Keffi	24.95 Note 1	26	1.05	4.04 Note 1
E. Keffi - Akwanga	12.48 Note 1	13 Note 2	0.52	4.04 Note 1
Total amount	144.58	150.63	6.05	4.04

Note 1: The amount of power transmission when power capacitors were not in operation in sections C-E was not available from the executing agency, so it was estimated using the average transmission loss rate of 4.04% between Gwagwalada and Apo, which was available.
Note 2: Since the amount of transmission when the capacitor was in operation in section E could not be obtained from the executing agency, the amount was assumed to be half of the amount of transmission in section D (assuming that half is supplied to Keffi and half to Akwanga).
Source: Prepared by the evaluators based on the information provided by JICA and the executing agency

The actual reduction in transmission losses (MW) was 6.05 MW compared to the target of 101.4 MW, which was a significant underachievement. The main reason for this can be attributed to large-scale projects such as the construction of new substation underway with the

[14] Appropriate value was around 132 kV, with 132.5 kV in 2021 result.

AFD's support. The target value was set based on a tidal flow analysis assuming that the AFD's project, which was scheduled for completion in 2017, had actually been completed. However, since the completion of the project has been delayed and the synergistic effects of the project have not been realized at this point, the realization of the effects at the time of the ex-post evaluation is considered to be limited compared to the target values. The actual reduction rate of transmission loss (%) was 4.04% compared to the target of 6.85%, and although it was below the target, it was not as large as the reduction amount. It can be inferred that the reduction amount of transmission loss will increase significantly as the scope of benefits is expanded after the completion of the AFD's project.

Based on the above, it can be concluded that the indicator of transmission loss for the 132-kV transmission lines was not achieved at the time of ex-post evaluation.

Indicator (3) Reduction amount of greenhouse gas emission (t/year)

The GHG emission reductions were calculated using the same method as in the planning phase.[15] The actual result was 13,141 t/year, compared to the target of 6,404 t/year, confirming that the GHG reductions were achieved to a large extent. This is due to the fact that the transmission loss reduction of electricity from thermal power plants supplied to the Apo and Keffi Substations was larger than the value assumed when the target was set.

Based on the above, the GHG reduction indicator was achieved.

Indicator (4) Number of households benefiting from improved supply of electricity (households / day)

As a result of the calculation in accordance with the methodology defined in the Preparatory Survey Report for the Project[16], the number of households benefiting from electricity supply in

[15] The following steps (1) and (2) were used to calculate the GHG emission reductions. Since Nigeria's main thermal power generation facilities are gas turbines, the thermal efficiency of the power generation facilities was set to 0.37 and the emission factor of natural gas was set to 0.0139, as in the planning.

(1) The offset calorific value of 257,828 (GJ/year) was calculated from the reduction in transmission losses 26,499* (MWh/year) × 3,600 (GJ/1,000MWh) ÷ 0.37 thermal efficiency of the power generation facility.

(2) The GHG emission reduction amount of 13,141 (t/year) was calculated from the reduced calorific value of 257,828 (GJ/year) × emission factor of 0.0139 (t C/GJ) × 44/12.

*An estimate of the transmission loss reduction for electricity generated by the thermal power plant supplying the Apo and Keffi Substations. The same reduction of 6.05 MW calculated in Indicator (2) is 52,998 MWh/year. Since approximately 50% of the electricity supplied to the Apo and Keffi Substation was generated by thermal power plants, this was set at half, or 26,499 MWh/year.

[16] Calculated according to the following steps (1) through (6). (1) Calculate apparent power (MVA) based on peak demand (MW), (2) Calculate dynamic reactive power (MVar) before the power capacitors were turned on, (3) Calculate dynamic reactive power (MVar) after the power capacitors were turned on, (4) Calculate active power (MW) after the power capacitors were turned on, (5) Calculate increased active power (MW), and (6) Calculate the number of households supplied with additional electricity by dividing by the average household power demand (kW/household) in the power supply area of the subject substations.

*The actual data on the number of supplied households is required for the calculation. However, since the executing agency and the distribution company did not have the data for the Apo Substation, the number of consumers in the substation's distribution area of approximately 160,000 households, as stated in the Preparatory Survey Report, was utilized.

the distribution area of the Apo Substation was 7,450 households/day, achieving the target of 5,400 households/day (138% compared to the target). The number of households served by the Keffi substation was 1,887 households/day, achieving the target of 1,700 households/day (111% of the target).

Based on the above, the indicator of the number of households benefiting from the improved supply of electricity was achieved.

Indicator (5) Number of consumers benefiting from improved supply of electricity (persons / day)[17]

The number of consumers benefiting from the improved electricity supply in the distribution area of the Apo Substation, calculated based on the results of indicator (4), is 33,525 persons/day, achieving the target of 24,300 persons/day (138% of the target). The number of beneficiaries at the Keffi Substation was 10,379 persons/day, achieving the target of 9,350 persons/day (111% of the target).

Based on the above, the indicator of the number of consumers benefiting from the improved supply of electricity was achieved.

3.3.1.2 Qualitative Effects (Other Effects)

None

3.3.2 Impacts

3.3.2.1 Intended Impacts

At the time of planning, the following two points were envisioned as the impact of the project implementation.

- Improved reliability of power supply
- Promotion of economic and social development

Although transmission losses improved as a result of the project implementation compared to before the start of the project, stable power supply still did not keep pace with the increase in power demand due to the population growth, etc., at the time of the ex-post evaluation, and improving power reliability remains an issue.

On the other hand, the satellite data analysis shows an increase in nighttime light in the districts of Abuja and Keffi, where the target substations are located, since 2019 after the completion of the project, indicating an increase in economic activity (see Box on the following pages for details).

[17] The number of consumers benefiting from improved supply of electricity (persons/day) was calculated by multiplying the number of beneficiary households in indicator (4) by 4.5 persons/household for Apo Substation and 5.5 persons/household for Keffi Substation, respectively, in accordance with the assumptions in the Preparatory Survey Report.

In the ex-post evaluation, a qualitative study was conducted to observe the qualitative effects of stabilizing electricity supply.[18] The results of the qualitative study are summarized in Table 6.

Table 6: Summary of Qualitative Survey Results

Expected Impact	Actual Impact
① Longer service life of electrical equipment due to high quality power supply close to rated voltage	In the period from 2019 to 2022, many respondents reported that malfunctions of several electrical equipment occurred (e.g., television malfunctions were identified in 4 out of 10 households). Although the implementation of the project resulted in a more stable electricity supply, the increase in the number of residents and appliances used has since further increased the demand for electricity, resulting in a situation where the electricity is again not adequately supplied or the supply voltage is unstable. As a result, the project was not able to supply high quality electricity close to the rated voltage compared to before the implementation of the project, and its contribution to extending the service life of electrical equipment is considered to be limited.
② Reduction of planned outage duration to develop and promote socioeconomy	Although no data on planned power outages were obtained from TCN, satellite data analysis showed an increase in nighttime light in the districts of Abuja and Keffi, where the target substations are located, since 2019 after the completion of the project. It can be inferred that the project has contributed to a certain extent to the stimulation of the economic activity.[19]
③ Stable use of medical equipment in hospitals	Hospitals reported that the high-quality power supply had reduced the frequency of breakdowns of medical equipment and the use of generators (e.g., generators no longer need to be used for surgeries that require a stable power supply). It was also confirmed that in the event of a power outage, the hospital contacted the power distribution company, and in some cases, adjustments were made on a priority basis for early restoration of power, indicating a more stable power supply among power consumers. The project is considered to have contributed to the stable use of medical equipment at the hospitals.
④ Improving the learning efficiency of school children	Schools commented that the use of stable electricity had allowed them to expand ICT classes, utilize handouts, and improve the efficiency of teachers' management of student information. In addition, some schools were providing high-quality education to more students by installing additional PCs, printers, and other equipment as the number of students increased. From the above, it can be assumed that the project has contributed to the improvement of the learning efficiency of school children.
⑤ Maintaining public safety in the project area through prolonged use of streetlights and security lighting	Based on interviews with nearby residents, there was no improvement in the available hours of streetlights and security lighting, and it appears that they are not contributing to maintaining public safety. All five households interviewed in the vicinity of the Keffi Substation reported a decrease in the number of hours that security lighting is available each day (10 to 6 hours, 8 to 3 hours, 4 to 1-2 hours, etc.). In addition, three of the five households interviewed reported an increase in nighttime thefts and snatch-and-grabs compared to before. The above results suggest that the contribution to the improvement of public safety has been limited.

[18] In the areas served by the Apo and Keffi Substation, three medical and health facilities, three schools, and eleven resident households (22 people) were selected using a purposive sampling method, and individual interviews based on a questionnaire were conducted.

[19] It should be noted that the increase in night light cannot be entirely attributed to the project.

Box: Satellite Data (Nighttime Light) Analysis

In this ex-post evaluation, satellite data (nighttime light[20]) was used to analyze the project's impact. It has been confirmed that nighttime light correlates with local economic activities and can be used as a proxy to measure the "promotion of economic and social development" envisioned in this project. Specifically, we calculated the average intensity of nighttime light for each of 19 local government areas (LGAs) in the target area, six LGAs in Abuja Federal Capital Territory and 13 LGAs in Nasarawa State, and then examined if the project contributed to the "promotion of economic and social development" by carefully observing the trends of nighttime light from 2014 to 2021 (see Figure 1 for target areas).

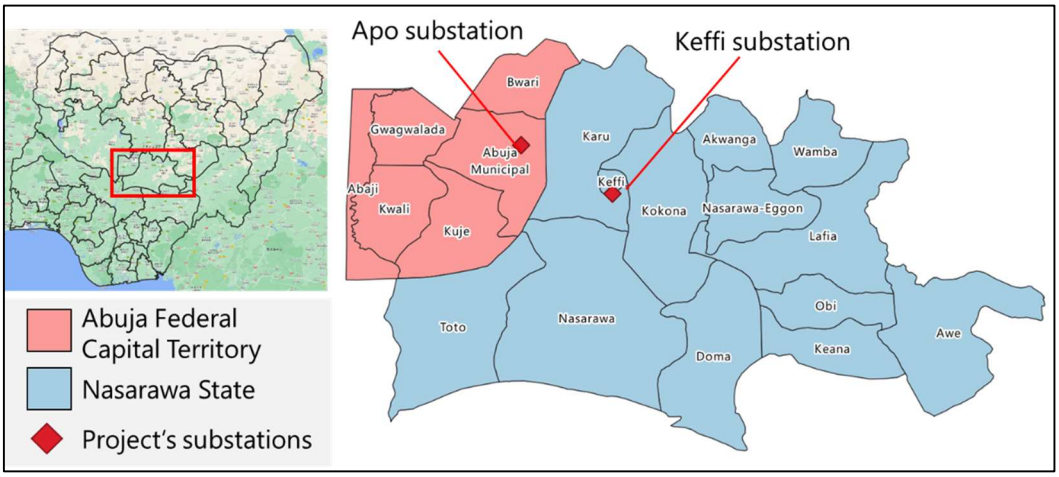


Figure 1: Project Target Areas

The results of the analysis are shown in Figures 2 and 3. Figure 2 shows that nighttime light has increased since 2019 in Abuja Municipal, where the project's substation is located. The adjacent Bwari also shows an increase compared to other administrative districts. Figure 3, which shows the results for Nasarawa State, also confirms an increasing trend from 2019 in Keffi, where the other project's substation is located. On the other hand, no specific trend was observed in the remaining LGAs. Based on the above results, it can be said that in Abuja Federal Capital Territory and Nasarawa State, there was a trend of increase in night light after 2019 in Abuja Municipal, Bwari, and Keffi, which are LGAs that had been economically active before the project. In particular, because Abuja Municipal and Keffi are the LGAs where the project's substations are located, it can be considered that the project contributed to the "promotion of economic and social development" in the project areas to a certain extent.

[20] The data used are Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB). Their resolution is 464 m, and they show the intensity of nighttime light (nanoWatts/cm2/sr) in the range of -1.5 to 193,565. The data from the eight years between 2014 and 2021, which were available at this time, were used for this analysis.

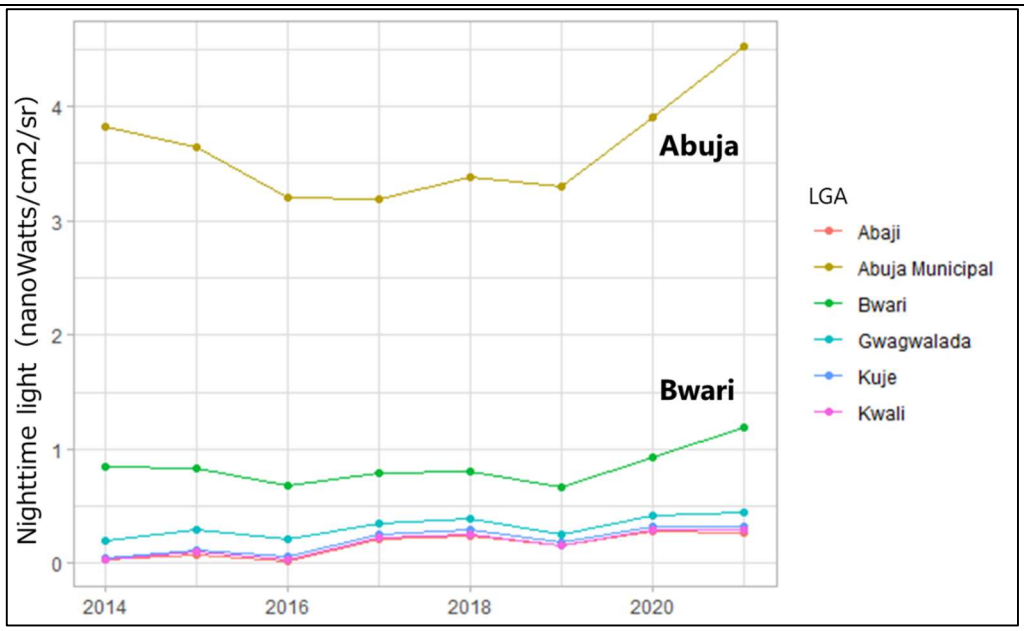


Figure 2: Changes in Nighttime Light in Abuja Federal Capital Territory

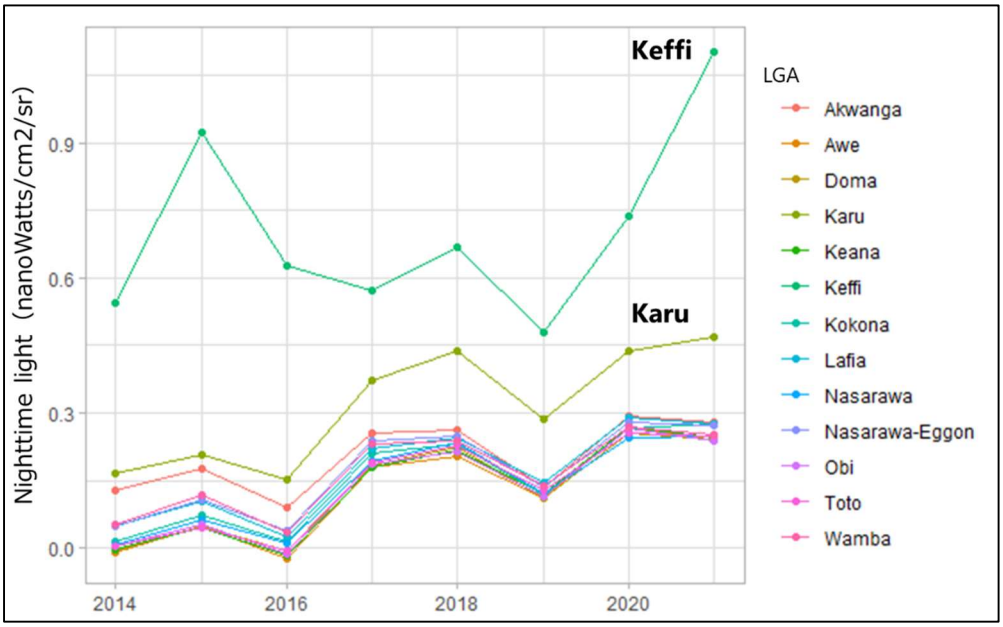


Figure 3: Changes in Nighttime Light in Nasarawa State

Overall, positive aspects were seen in large medical and educational facilities, where stable power supply led to the reduced operating costs and improved the quantity and the quality of services.[21] On the other hand, there were also aspects where the power supply remained unstable and the contribution to improved security was limited.

[21] The coordination was made with the power distribution company at the hospital, for early restoration of power during power outages, leading to a stable supply of electricity, in particular.

3.3.2.2 Other Positive and Negative Impacts

1) Impact on the Natural Environment

This project was classified as Category C based on the "Guidelines for Environmental and Social Considerations" (April, 2010). According to the interviews with the implementing consultant, no negative impacts on the natural environment occurred during the procurement and installation of the equipment. According to the executing agency, no negative impacts on the natural environment were identified by the time of the ex-post evaluation.

In addition, the reduction of transmission losses contributes to the reduction of fuel used for thermal power generation and thus to the reduction of greenhouse gases, which has a positive impact on the natural environment.

2) Resettlement and Land Acquisition

The project was conducted on TCN's sites, and no resettlement or land acquisition occurred.

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

The results of the interviews with TCN did not identify any negative impacts on gender equality, marginalized people, social systems and norms, human well-being or human rights. Cases were identified where people, including women, started small businesses (hair salons, grain and other crushing, weaving, etc.).

The implementation of the project improved the rate of voltage improvement in the target area, which was assumed at the time of planning, and stable and efficient power supply was realized mainly in large-scale facilities. Interviews with hospitals and schools also confirmed that power outages had decreased. As a result, the frequency of breakdowns of medical equipment and the use of generators decreased, enabling the stable and efficient use of medical equipment at hospitals. In schools, the learning efficiency of school children improved through the expansion of ICT classes, the use of handouts, and more efficient information management of students by teachers. The analysis using nighttime light also indicates that economic activities have been stimulated in the feeding areas of both the Abuja and Keffi Substations where power capacitors were installed. On the other hand, in the residential areas, it was seen that demand of electricity had been growing faster than the supply, as many residents said that the power supply had been more unstable in recent years than in the past due to the increase in the number of residents moving into the area with stable power supply. In addition, no natural environmental or other negative impacts were identified. The reduction in transmission losses contributed to the reduction of greenhouse gases generated by thermal power generation, which can be said to have a positive impact on the natural environment.

As a result of the above, this project has mostly achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and System

Targets for the power sector for the period up to 2025 in the national development plan *Nigeria's Medium Term National Development Plan 2021-2025* include increasing transmission capacity of electricity, reducing its transmission losses, and improving access to electricity.

The project is consistent with the government of Nigeria's development plan up to 2025, and the sustainability of the project's effects is ensured in terms of policies and systems.

3.4.2 Institutional/Organizational Aspect

The organizational structure of TCN consists of 34 departments with a total staff of 3,821 (as of 2020). The number of staff belonging to the departments in charge of operation and maintenance of the facilities covered by the project is shown in Table 7.

Table 7: Number of People Belonging to the Department in Charge of Operation and Maintenance at the Facilities Covered by the Project

Name of Department	Role	Apo Substation (persons)	Keffi Substation (persons)
System Operation (SO)	Operation and daily inspection	13	6
	Data recording and management		
Transmission Service Provider (TSP)	Periodic inspection and maintenance	80	10
	Repair in case of breakdown		

Source: Prepared by the evaluators based on the information provided the executing agency

The human resources and organizational structure necessary for operation and maintenance of the equipment installed in this project are in place. As planned, maintenance and management are handled by the System Operation department (the department responsible for operation, daily inspections, data recording and management) and the Transmission Service Provider department (the department responsible for periodic inspections, maintenance, and repairs in case of breakdowns), each with the necessary skills. The daily operation and monitoring of each facility are also handled by dedicated operators. No breakdowns or malfunctions due to insufficient personnel or skills have been observed.

Based on the above, the sustainability of the project's effects in institutional and organizational aspects is considered to be high.

3.4.3 Technical Aspect

According to TCN, the personnel in charge of maintenance and operation possess the technical skills necessary to maintain the equipment, and no maintenance and operation issues have occurred. The technicians have acquired the knowledge to operate and maintain the installed facilities through technical guidance in the training programs. In addition, necessary training has been provided, including induction training, HSE (health, safety, and environment) training, on-the-job training, and training by outside instructors. Furthermore, they refer to the manuals provided by the project for troubleshooting, etc.

Based on the above, there are no particular technical issues.

3.4.4 Financial Aspect

TCN's published income and expenditure statements for 2018-2020 are cited in Table 8.

Table 8: Statement of Income and Expenditure of TCN[22]

(In millions of Naira)

Item	2018	2019	2020
1. Sales	109,870	112,300	156,990
2. Cost of sales	(15,440)	(20,840)	(22,640)
Repair and maintenance expenses for facilities and equipment	(4,290)	(4,880)	(6,510)
Depreciation and amortization	(11,150)	(15,960)	(16,130)
3. Gross profit	94,430	91,460	134,350
4. Other income	3,160	130	600
5. Administrative expenses	(84,110)	(87,680)	(101,530)
6. Operating Income	13,480	3,910	33,420
7. Net financial income/(expense)	(440)	1,080	4,540
8. Income before income taxes	13,040	4,990	37,960
9. Net income	4,620	(1,770)	18,860

Source: Prepared by the evaluators based on the information provided by the executing agency

TCN's operation was profitable in 2018 and 2020. Although a deficit occurred in 2019, it was mainly due to a large investment in transmission lines, and no issues were identified with the operating status itself. TCN confirmed that it has a sufficient budget for the maintenance of the equipment installed by the project.

Although the cost of each substation is not disclosed, it can be inferred that the necessary investments have been made to operate both the Apo and Keffi Substations, as the total investment in substation facilities and equipment has increased over the years.

Based on the above, the financial sustainability of the project's effects is high, as confirmed by its sound financial condition, adequate budget for equipment maintenance, and proactive investment in facilities and equipment.

[22] Numbers in parentheses indicate expenditures or negative values.

3.4.5 Environmental and Social Aspect

No negative impacts on the natural environment were identified. In addition, the project contributed to the reduction of greenhouse gas emissions through the reduction of transmission losses, which is considered to have a positive impact on the natural environment.

3.4.6 Preventative Measures to Risks

Although no malfunctions have occurred since the equipment was installed, malfunctions of the installed equipment are a risk. However, TCN has the human resources and budget to maintain and repair the equipment, and spare parts are available locally and can be procured promptly, and the manual provided by the project describes troubleshooting methods. Therefore, the company is considered to be able to handle issues that may arise.

Based on the above, it is concluded that there is no issue with the risk related to the operational sustainability.

3.4.7 Status of Operation and Maintenance

At the time of the ex-post evaluation, the equipment was in good working condition, and no malfunctions due to lack of maintenance had occurred since its installation. Voltage measurements and records, daily inspections, and periodic maintenance have been performed as planned. No issues were also observed in the procurement of spares parts. On the other hand, the status of installation and maintenance of the substations' equipment was not recorded in a ledger, and it was only managed on a map with no detailed information. The specifics of each item are as follows.

- Operation and inspection records were always kept, and it was confirmed that operational records and inspections were performed on a daily basis.
- The manuals were kept at the substations and used for troubleshooting.
- Regarding the ledgers of substation facilities, at both the Apo and Keffi Substations, only the layout of each facility was managed on a map, not on a ledger, and installation records, maintenance schedules, etc., were not centrally managed. In addition, the data such as transmission losses were not recorded and managed in the system. According to TCN, a project for asset and data management has recently been started and the asset and data will be managed in a database in a few years.
- It was confirmed that spare parts were well stored and that a system was in place for prompt supply of the parts from local distributors of Japanese companies.

Therefore, there are no particular issues in terms of operation and maintenance.

From the above, it can be said that although there were some minor issues in operation and maintenance, there are good prospects for improvement and resolution. Therefore, sustainability of the project effects is high.

4. Conclusions, Lessons Learned and Recommendations

4.1 Conclusion

The project aimed to reduce transmission power loss and improve the power supply to the Abuja Federal Capital Territory and the surrounding area (Nasarawa State) by installing power capacitors at the Apo and Keffi Substations, thereby contributing to the promotion of economic and social development of the target area. The project was consistent with Nigeria's development policies and needs at the time of the planning and the ex-post evaluation, and the project plan and approach were appropriate based on lessons learned from similar past projects. As for the internal coherence, there was no specific coordination with other JICA projects, which was initially expected. As for the external coherence, there was some coordination with other projects through the executing agency. However, the implementation of those projects was significantly delayed, and the results of the coordination were limited. On the other hand, the consistency with Japan's ODA policy at the time of planning was observed. Therefore, its relevance and coherence are high. Although the project period slightly exceeded the plan, the project cost remained within the plan, and the efficiency of the project is high. The project increased the rate of voltage improvement in the target area, which was assumed at the time of planning, and stable and efficient power supply was realized mainly for large-scale facilities. Although some issues persist, such as unstable power supply due to the population growth in the target area, the effectiveness and impacts of the project are high, as it achieved the overall expected effects and impacts, and no negative impacts were observed. There were no organizational, technical, or financial issues in the operation and maintenance of the project, and the facilities were operating without any issues. Therefore, the sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Recommendations to Nigeria's Federal Ministry of Power and TCN:

The transmission losses seem to have improved after the start of the project. However, the stable power supply was still not realized due to the increase in power demand caused by the population growth and other factors at the time of the ex-post evaluation, hence improving power reliability remains an important issue. Although this project supported the construction of substation facilities and the equipment installation, the main reasons for the unstable power

supply are that the population growth in the target areas is greater than expected, as well as the insufficient generation capacity, the aging transmission and distribution facilities, etc. To resolve the underlying factors, additional capital investment is considered to be necessary, not only in the transmission facility, but also in the generation and distribution facilities. In order to make capital investments, it will be necessary to take measures such as financing (procurement through investment financing, revision of generation tariffs, and improved collection rate of electricity charges from the users), the stable procurement of natural gas, and the promotion of the entry of independent power producers (private companies that sell electricity wholesale).

Recommendations to TCN:

Although the equipment and devices were inspected and maintained regularly and operated in good condition, the ledgers of substation equipment were only managed on a map at both the Apo and Keffi Substations, and the installation records and maintenance periods were not centrally managed. It is necessary to implement ledger management of facilities and formulate maintenance management plans, in order to build an environment where information is passed down over the years and appropriate operation is carried out.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Development of power grids with a view to providing a stable supply of electricity to end users (electricity consumers)

Although the project achieved its project objectives, the entire power grid in the target area still had an unstable supply of electricity, due to the insufficient power generation capacity, and the insufficient supply capacity caused by the population growth. The issues of the insufficient power generation capacity and the aging transmission/distribution facilities, which are outside the scope of this project, are major reasons for power supply instability. However, the situation of unstable electricity supply remains unchanged from the viewpoint of consumers. While this project supports the improvement of substation facilities, which was the urgent matter, other issues that exist on the power grid need to be resolved, and the entire power grid needs to be improved. In implementing this project, it would have been necessary for power supply agencies including TCN under Nigeria's Federal Ministry of Power to draw up an integrated development plan based on an overall picture of the power supply in the Abuja area, and to sequentially improve the facilities and the equipment starting with those of the highest priority. Therefore, when planning

similar projects, it is important for the executing agency and JICA to analyze the issues on the power grid, taking into account population growth and other matters first, and to set priorities then. After setting the priorities, clearly setting the responsible person(s) and schedule for improvement of necessary facilities and the equipment and implementing them sequentially will be essential for the stable supply of electricity to the target area. It is desirable that JICA analyze the implementation status of related projects in this context, and plan and implement effective projects.

(End)

Republic of Malawi

FY2021 Ex-Post Evaluation Report of Technical Cooperation Project

"Project for Community Vitalization and Afforestation in Middle Shire"

"Project for Promoting Catchment Management Activities in Middle Shire"[1]

External Evaluators: Keisuke Nishikawa, Hiroshi Nishino

Metrics Work Consultants Inc.

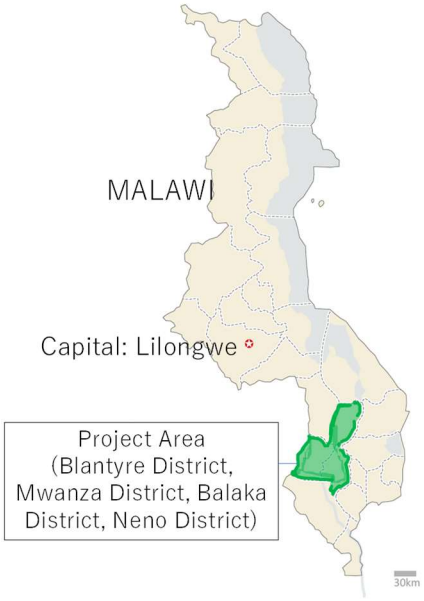
0. Summary

The "Project for Community Vitalization and Afforestation in Middle Shire" and the "Project for Promoting Catchment Management Activities in Middle Shire" as a whole aimed to improve the livelihoods through sustainable forest resource management by village farmers in the southern region of Malawi, where the forest area had significantly decreased. Both projects were consistent with Malawi's development plans and needs at the time of planning and completion, and with Japan's ODA policy at the time of planning. In addition, while there was limited coordination with the support by other organizations, there were synergies observed with JICA's related projects and within the expected scope. Therefore, the relevance and coherence of this project is high. The Project Purposes and the Outputs of both projects were generally achieved, and while the effects were widely seen in the areas targeted by the projects, their expansion to other areas was limited, and the Overall Goals were not fully achieved. However, the effectiveness and impacts of the two projects as a whole are high, as the direct support provided by the project was highly effective. The overall efficiency of the project was judged to be high, since the project period was within the planned period while the project cost exceeded the planned amount for both projects. Regarding the sustainability of the effects generated through the two projects, there were some issues in terms of policies and systems, as well as major financial issues, and it was confirmed that the technology was not fully utilized. Therefore, the sustainability of the project is moderately low.

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

[1] The "Project for Community Vitalization and Afforestation in the Middle Shire" was abbreviated as COVAMS, and the "Project for Promoting Catchment Management Activities in Middle Shire" was commonly referred to as COVAMS II. In this evaluation report, these projects are considered as a single project and COVAMS is referred to as "Phase 1" and COVAMS II as "Phase 2."

1. Project Description



Location of the Project
(Source: External Evaluator)

A village where trees were planted in this project
(Source: External Evaluator)

1.1 Background

At the time of planning of this project, a population pressure was rising in Malawi, and deforestation, soil degradation, and water resource depletion were occurring due to the expansion of agricultural land and timber harvesting. As a result, the livelihood foundation in rural areas, where about 80% of the population resided, were being threatened. In particular, the forest areas, the source of wood and charcoal, which account for 90% of domestic fuel consumption, had been decreasing. In 1990, 38% (4.2 million hectares) of the country was covered by forests, but in 2005, the area had decreased to 31% (3.4 million hectares). This declining trend was particularly pronounced in the densely populated southern region of Malawi.

Forest resources in the middle area of Shire River, which flows from the southern tip of Lake Malawi to the southern region of the country, were rapidly declining due to the collection of firewood in line with the increase in the population of Blantyre City, Malawi's largest commercial city, which is located near the area. This caused a decrease in the water retention capacity of the land and a decline in agricultural productivity due to a decrease in soil fertility in the area, further exacerbating the poverty of the local residents whose livelihoods were fragile. In addition, the sediment that flowed into Shire River pushed up the riverbed, causing a decline in the power generation capacity of hydropower facilities on the Shire River system, which provided most of the country's power generation, and the increase in flooding downstream.

Sustainable forest resource management by local communities was essential to address these problems, and assistance was needed to realize it.

1.2 Project Outline

Project for community vitalization and afforestation in Middle Shire (Phase 1)	Overall Goal		Villagers in the target villages practice sustainable forest management (including soil conservation) through the improvement of livelihoods.
	Project Purpose		Productive activities including tree growing and soil erosion control are implemented with consideration of forest conservation and rehabilitation in the target villages.
	Outputs	Output 1	The target villagers acquire knowledge and skills regarding productive activities including tree growing and soil erosion control.
		Output 2	Capacity of the target villagers is enhanced to access necessary resources for productive activities including tree growing and soil erosion control.
		Output 3	Capacity of the counterparts is enhanced in supporting productive activities including tree growing and soil erosion control.
	Total cost (Japanese Side)		401 million yen
	Period of Cooperation		November 2007- November 2012
	Target Area		Blantyre District (TA[2] Kuntaja, TA Kapeni)
Project for Promoting Catchment Management Activities in Middle Shire (Phase 2)	Overall Goal		Catchment management through farmers' activities (CMFA[3]) using COVAMS approach[4] is widely implemented in the target districts.
	Project Purpose		CMFA through COVAMS approach is institutionalized in the target districts.
	Outputs	Output 1	Promotion for the target districts and the ministries concerned to ensure institutionalization and budget for COVAMS is carried out.
		Output 2	Capacity for implementing the COVAMS approach by officers of the target districts is improved.

[2] Traditional Authority: In Malawi, land belongs to local communities, and chiefs manage the land on behalf of the entire community according to customary land laws established in each territory.
[3] Community-based catchment management activities using soil conservation and improvement of water harvest technologies (improved contour ridges, tree planting and growing, and gully reclamation)
[4] The COVAMS approach refers to a village training method that utilizes the 'Specified Village Training Approach (SVTA).' SVTA is a technology dissemination method that targets a large number of residents and conducts training in the places where they live, based on the needs of the residents, but with a narrow focus on training areas. This enables the project to steadily spread relatively simple dissemination content over a wide area in a short period of time by having project-trained government extension workers train Lead Farmers (LFs) and having LFs manage the entire process of training all farmers in their area of responsibility under the management of the project.

		Output 3	Effectiveness of the COVAMS approach, both extension method and extension subject, is verified.
		Output 4	The commitment of the COVAMS approach among leaders of all levels is enhanced.
	Total cost (Japanese Side)		538 million yen
	Period of Cooperation		April 2013 - March 2018
	Target Area		Blantyre District (TA Lundu, TA Chigaru), Mwanza District (TA Nthache, TA Govati, TA Kanduku), Balaka District (TA Chanthunya, TA Phalura), and Neno Dictrict (TA Mlauli, TA Symon)
Implementing Agency			Department of Forestry, Ministry of Forestry and Natural Resources
Other Relevant Agencies/ Organizations			Department of Agricultural Extension Services, Ministry of Agriculture, Irrigation and Water Development Department of Land Resources, Ministry of Agriculture, Irrigation and Water Development Department of Community Development, Ministry of Civic Education, Culture and Community Development
Organization in Japan			Forestry Agency, Ministry of Agriculture, Forestry and Fisheries
Related Projects			<Technical Cooperation> (Development Survey) - The Master Plan Study on Watershed Rehabilitation in Middle Shire (1999-2000) - Pilot Study on Community Vitalization and Afforestation in Middle Shire (2002-2004) (Japan Overseas Cooperation Volunteer) - Tree-Planting Extension Officer (2006-2008) (JICA Expert) - Forest Conservation and Management Advisor (2012-2014) <Other International Organizations> USAID: Community Partnerships for Sustainable Resource Management II (2004-2009) EU: Improved Forestry Management for Sustainable Livelihoods Programme (2006-2009) World Bank: Shire River Basin Development Project (2012-2018) UNDP/GEF: Private Public Sector Partnership on Capacity Building for SLM (Sustainable Land Management) in the Shire River Basin (2010-2014)

1.3 Outline of the Terminal Evaluation

Since the efforts in Phase 1 were carried over to Phase 2, this section describes the expected achievement of the Project Purpose and the Overall Goal and the recommendations at the time of terminal evaluation of Phase 2.

1.3.1 Achievement Status of Project Purpose at the Terminal Evaluation

The four outcomes planned for Phase 2 were achieved or largely achieved by the time of terminal evaluation, leading to the achievement of Project Purpose. Two indicators related to Project Purpose were also expected to be achieved by the completion of the project.

1.3.2 Achievement Status of Overall Goal at the Terminal Evaluation

Regarding the further dissemination of CMFA utilizing the COVAMS approach, it was expected that Overall Goal would be achieved within three years after the completion of this project, since dissemination activities based on the "Lean COVAMS (low-input COVAMS) approach" had already started in this project to promote dissemination in other regions to the extent possible without investing a large amount of budget, and examples of its application in the projects supported by other donors had been observed.

1.3.3 Recommendations from the Terminal Evaluation

In the terminal evaluation, the following two recommendations were made regarding the activities after the completion of this project.

(1) The district governments in the four target districts of this project need to develop an action plan for dissemination activities for three years after the completion of the project in order to disseminate CMFA based on the COVAMS approach to the villages and TAs that were not covered by this project and to strengthen CMFA in the villages that received support under this project.
(2) In order to mobilize the necessary resources for sustainable CMFA based on the COVAMS approach, it is essential to verify and provide concrete evidence of the effectiveness of CMFA introduced in this project in watershed management. Therefore, it is important to design and introduce a simple and feasible monitoring system to record changes in forest cover, soil runoff, etc. at the sites where CMFA is implemented by means of fixed-point observation using georeferenced digital photographs or satellite images.

2. Outline of the Evaluation Study

2.1 External Evaluator[5]

Keisuke Nishikawa[6] and Hiroshi Nishino, Metrics Work Consultants Inc.

2.2 Duration of Evaluation Study

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

Duration of the Study: October, 2021 – January, 2023

Duration of the Field Study: April 30 - May 26, 2022; September 25 - October 5, 2022

3. Results of the Evaluation (Overall Rating: B[7])

3.1 Relevance/Coherence (Rating: ③[8])

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Malawi

The *Malawi Growth and Development Strategy (MGDS)* (2006-2011), which was the development plan at the time of planning Phase 1 (2007), identified natural resource conservation as one of the priority areas and set a medium-term goal of achieving sustainable forest use and management and reducing the degradation of forest resources through initiating reforestation programs, strengthening afforestation activities and collaborating with the private sector. In the forestry sector, the *National Forest Policy* (1996-2015) set the goal of maintaining national forest resources conducive to the improvement of the quality of life of the people through forest conservation, and the *National Forest Plan* was formulated in 2001 as a guideline for the smooth implementation of the policy. The *National Forest Plan* had a particular emphasis on establishing community-based forest management, improving the livelihoods of small landowners, and strengthening forestry extension.

The development plan at the time of completion of Phase 1 and at the time of planning of Phase 2 (2012/2013) was the *Malawi Growth and Development Strategy II (MGDS II)* (2011-2016) at the national level, which emphasized poverty reduction and food security through sustainable land management. In addition, the medium-term goal was to develop various institutions and implement measures to mitigate the impacts of climate change and development pressures on forests and other natural resources and the natural environment. The *Agriculture Sector Wide Approach (ASWAP)* (2011-2015) and the *Community Development Policy* (2012-2017) were formulated in line with this

[5] Nishino was in charge of satellite data analysis, and Nishikawa was in charge of other work (including field surveys).
[6] Participated in the survey as an assisting member from QUNIE CORPORATION
[7] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[8] ④: Very High ③: High, ②: Moderately Low, ①: Low

national plan, and both projects, which aimed to promote watershed conservation activities by farmers, were consistent with these policies. In addition, the "National Forest Policy" and the "National Forest Plan" remained in effect during this period.

The *Malawi Growth and Development Strategy III (MGDS III)* (2017-2022), the national plan at the completion of Phase 2 (2018), emphasized sustainable forest management in the agriculture and climate change sectors. In the energy and environment sector, securing sustainable fuel wood was also mentioned, as well as the importance of afforestation. At the sectoral level, the *National Forest Policy* was updated (covering the period 2016-2021) to promote sustainable management of forest resources with the policy goal of restoring forest cover to 30% of the total land area by 2021 (the *National Forest Plan*, formulated in 2001, remained in effect). In addition, the *National Forest Landscape Restoration Strategy* was launched in June 2017 to achieve poverty eradication. The strategy also aimed to accelerate the implementation of the *National Forest Policy* and provided a plan of action on forest management, soil and water conservation, and river basin restoration.

As mentioned above, various policies, plans, etc. were developed, and the table below summarizes their positions with both projects at the time of planning and completion.

Table 1: Development Policies at the Time of Planning and Completion of Both Projects

		At the time of planning	At the time of completion
Phase 1	National level	MGDS (2006-2011)	MGDS II (2011-2016)
	Sector level	National Forest Policy (1996-2015) National Forest Plan (2001)	National Forest Policy (1996-2015) National Forest Plan (2001) ASWAP (2011-2015)
Phase 2	National level	MGDS II (2011-2016)	MDGS III (2017-2022)
	Sector level	National Forest Policy (1996-2015) National Forest Plan (2001) ASWAP (2011-2015) Community Development Policy (2012-2017)	National Forest Policy (2016-2021) National Forest Plan (2001) Community Development Policy (2012-2017)

Source: Prepared by the evaluator based on each policy document

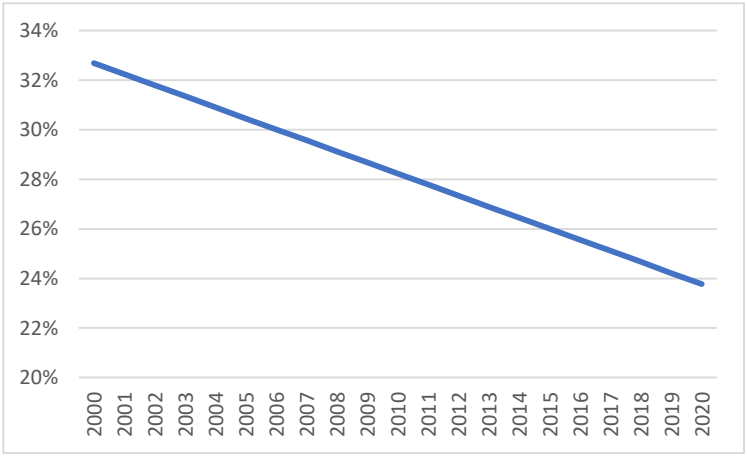
Based on the above, it was confirmed that forest management was emphasized in Malawi's national development policies at the time of planning and completion of both projects, and that various sector plans based on these policies were also consistent with the direction of this project.

3.1.1.2 Consistency with the Development Needs of Malawi

As described in the project's Background, the project area was facing the following challenges.

At the time of the planning of Phase 1, Malawi's forest area had been decreasing, from 38% of the country's land covered by forest in 1990 to 31% in 2005. In the southern region of Malawi, forest resources in the middle reaches of Shire River, the source of supply for firewood for cooking and heating, had been depleting as the population in Blantyre City was increasing. As a result, flooding was occurring due to the reduced water retention capacity of the land in the area, and agricultural productivity was declining due to the reduced soil fertility, which was worsening the poverty conditions of the rural population in particular. In addition, sediment discharged from depleted forest resources flowed into Shire River and pushed up the riverbed, causing massive sediment deposition at several dams in the river system and reducing the power generation capacity of the hydroelectric power plants that were Malawi's main source of power.

As shown in Figure 1, the forest area in Malawi continued to decline, and by 2018, when Phase 2 was completed, it had dropped to 25%.



Source: Compiled by the External Evaluator from the World Bank data

Figure 1: Trends in Malawi's Forest Area as a Percentage of Land Area

With regard to the status of forests and soils in the target areas of both projects, where residents were the main actors in management and use, no general data existed in each district, and quantitative forest cover, forest area, deforestation rate, and soil degradation status were unknown. However, regarding the forests and soils in the target areas at the completion of Phase 2, issues and needs shown in Table 2 were identified.

Table 2: Issues and Needs Related to Forests and Soils at the Completion of Phase 2

	Issues and Needs
Forest	- Forest area continues to decline in general, even in the areas covered by the project. - Monitoring of forest conditions is inadequate. - Coordination between forest and agricultural stakeholders is lacking. - There are still communities that cut down trees for charcoal production as a means of livelihood (especially in Blantyre District). - Financial and human resources are lacking for sustainable use. - Insufficient rainfall makes nursery conservation difficult, and afforestation is not progressing well.
Soil	- Soil runoff caused by heavy rainfall is not always thoroughly addressed. - Soil runoff and nutrient loss (land degradation) is progressing. - Sediment runoff into Shire River is not only a problem only in the southern region, but also has significant impacts on the availability of hydroelectric power plants that supply electricity to the rest of the country.

Source: Information provided by each district forest office, Project Completion Report of Phase 2

Although sufficient data on the target areas were not available, the forest resources in the southern region generally continued to decline, according to the officials of the implementing agency. In addition, as described below (Box 1), the analysis using satellite data in this ex-post evaluation also confirmed that forest area has been decreasing in both target and non-target TAs. Therefore, it can be said that the forest area is consistently decreasing throughout the country, including the southern region of Malawi, and that conservation needs are still high.

Based on the above, it is considered that the two projects that supported forest conservation activities in the Shire River basin were highly consistent with these development needs.

3.1.2 Coherence (Rating: ③)

3.1.2.1 Consistency with Japan's ODA Policy

At the time of the planning of Phase 1, the project was positioned as a "Rural Livelihood Diversification Program" in the "Food Security" area in JICA's Country-specific Program, and was expected to contribute to food security by increasing cash income through sustainable management and utilization of natural resources and income generating activities linked to it, thereby securing livelihood options other than maize production, the main agricultural product in Malawi.

At the time of the planning of Phase 2, the "Country Assistance Policy for the Republic of Malawi (April 2012)" and the "JICA Country Analysis Paper for Malawi (April 2012)" stated that assistance to lift the country out of severe poverty was the

basic policy of assistance, and that infrastructure development to foster industries such as agriculture and mining would be a focused area of assistance. The project was positioned under the "Agricultural Development and Natural Resource Management Program," which emphasized natural resource management efforts for soil conservation and sustainable use of water for agriculture to ensure the long-term sustainability of agricultural production while considering the high population density and rapid population growth. Furthermore, the implementation of appropriate watershed management was identified as an important issue for Malawi, which relied largely on hydropower for electricity generation.

As described above, both Phase 1 and Phase 2 were in line with Japan's ODA policy.

3.1.2.2 Internal Coherence

<Phase 1>

Prior to the implementation of Phase 1, "The Master Plan Study on Watershed Rehabilitation in Middle Shire" was conducted from 1999 to 2000 and the "Pilot Study on Community Vitalization and Afforestation in Middle Shire" was conducted from 2002 to 2004 in the project area, and a model was proposed and demonstrated that combined afforestation, agroforestry, and income-generating activities to increase short-term incentives and continuously implement profitable afforestation activities over a long span (hereinafter referred to as the "demonstration model")[9]. In addition, the PRODEFI model[10] was incorporated into the demonstration model in order to efficiently and effectively expand the model to neighboring villages. In Phase 1, the outcomes of the various activities (forestry and income generation activities), the method of coordination among the resident action groups and counterpart organizations, the functions of the project implementation unit, and the method of selecting target villages, all of which were conducted in the previous demonstration study, were to be used to the maximum extent possible to promote the project efficiently.

In the ex-post evaluation, it was unclear to what extent the content and methods of the demonstration study were used in the selection of target villages for Phase 1, but

[9] In the demonstration study, a pilot project implementation unit, consisting of government officials in the target area, was established to prevent overharvesting of forest resources and to conduct sustainable forest management through livelihood enhancement activities based on agroforestry practices with the cooperation of each village. The results of this study showed that the livelihood improvement activities were effective.

[10] A model proposed in the "Project on the Integrated Community Forestry Development Project" in Senegal. It is a training-centered regional development approach, defined as "a methodology that draws out the vitality that residents possess and links that vitality to the revitalization of individual and organizational activities, and then to the development of the communities." Specifically, this is an approach to (1) start from local training needs, (2) use local (human and material) resources, (3) not screen the training participants, (4) target a large number of participants, and (5) conduct training on site. This approach was considered to be effective in this project as well, and it was believed that experiences and lessons learned on how to utilize local resources and on measures to improve the capacity of local residents and extension workers could be utilized.

the agroforestry practices were applied to the Phase 1 activities, and it can be said that there are sufficient linkages. The target area is also the same as the TAs of Phase 1, and it can be said that there was a sufficient linkage. In addition, the outcomes of the demonstration study were applied in neighboring villages, contributing to the smooth implementation of the activities in the project.

In addition, one Japan Overseas Cooperation Volunteer was dispatched to Blantyre District to follow up on the afforestation activities, and it was expected that the project would be implemented efficiently. According to the implementing agency, the Japan Overseas Cooperation Volunteer was routinely involved in Phase 1 activities together with the extension workers of the Department of Forestry, and made site visits and follow-ups. He also prepared activity reports and attended regular meetings, which is considered to have contributed to the steady implementation of Phase 1 activities.

<Phase 2>

For Phase 2, a Forest Conservation and Management Advisor was dispatched to the Department of Forestry at the time of planning (2012-2014). It was expected that this project would make use of the advisor's knowledge on Malawi's forest policy and forest conservation and management planning that he would acquire through his field activities. In fact, the advisor provided advice and coordination on planning and implementation of the activities related to watershed conservation from the standpoint of supporting the experts and the implementing agency involved in Phase 2, which is believed to have contributed to the promotion of the project activities.

The synergistic effect of the collaboration between the project and JICA's related projects, such as Japan Overseas Cooperation Volunteer, and the advisor, is considered to have been generated within the expected scope of the project.

3.1.2.3 External Coherence

<Phase 1>

At the time of the planning of Phase 1, the following assistance was mainly provided in the field of forest conservation in the southern region of Malawi.

- USAID “Community Partnerships for Sustainable Resource Management (COMPASS II)” (2004-2009): Supported afforestation, beekeeping, mushroom cultivation, and so on.
- European Union (EU) “Improved Forestry Management for Sustainable Livelihoods” (2006-2009): Supported forest resource management, forest resource advocacy, and livelihood improvement activities in Blantyre District.

- In addition, Total Land Care (NGO) supported soil conservation, afforestation, and crop diversification for improved nutrition. DAPP (NGO) supported afforestation, agroforestry, and rural teacher training. In Phase 1, it was envisioned to collaborate with these NGOs and utilize training instructors etc., as common resources.

When the status of coordination and collaboration with these other donors was confirmed during the ex-post evaluation, USAID and the EU were also implementing the projects in the field of forest management, but there were no specific linkages with this project. On the other hand, it was confirmed that the extension workers and other relevant personnel whose capacities had been improved in Phase 1 were being utilized as resource persons with Total Land Care, which was working in the areas of environmental conservation, water and sanitation, and irrigation to improve the livelihoods of rural communities in Blantyre District from 2005 to 2012, and the United Nations Development Programme (UNDP), which was implementing a project to support sustainable land management in Mwanza District.

<Phase 2>

At the time of the planning of Phase 2, the following assistance was mainly provided as the projects in related fields.

- World Bank “Shire River Basin Development Project” (2012-2018): A framework for collaborative management of the Shire River basin was established and watershed conservation activities were implemented to restore degraded soil and forest resources. Through Phase 2, specific methods of watershed conservation activities by farmers, which had been accumulated based on the field activities, would be established, and therefore, the COVAMS approach would be lobbied to the World Bank so that it would be reflected in the revised national-level watershed conservation guidelines that the World Bank was supporting, and the approach was expected to be eventually reflected at the policy level in Malawi. In addition, since the same activities as Phase 2 would be carried out, it was planned that information would be shared and discussed through the Shire River Basin Conservation Coordinating Council led by JICA. In addition, it was also stated that the immediate activities would be coordinated so that there would be no overlap in the areas covered by the activities.
- UNDP/Global Environment Facility (GEF) "Private Public Sector Partnership on Capacity Building for SLM (Sustainable Land Management) in the Shire River Basin" (2010-2014): The project was establishing a collaboration model, including the implementation of training by district officials and extension workers, and the provision of materials from the project to farmers whose capacity had been

strengthened through Phase 1 training.

The ex-post evaluation confirmed if these expected coordination and collaboration were actually made, and found that coordination was made with the World Bank to avoid overlapping of TAs to be targeted by the projects. Specifically, the target of Phase 2 was changed to TA Symon (47 villages) to avoid duplication because the World Bank's support program targeted TA Dambe (50 villages) which was also initially targeted in Phase 2. Other than that, there was no specific collaboration with the World Bank and no specific reflection of the COVAMS approach in the guidelines that the World Bank was supporting for revision. On the other hand, with the UNDP/GEF-supported project, it was observed that the extension workers whose capacities had been enhanced through this project utilized their knowledge in the other project as well. However, no specific outcomes of the coordination or collaboration were observed.

It was confirmed that both projects were consistent with Malawi's development plans and development needs at the time of planning and completion. With the assistance by other donors, coordination and collaboration with some donors were observed within the expected scope, but no outcomes were observed from them. On the other hand, both projects were found to be consistent with Japan's ODA policy at the time of planning, and the collaboration and synergies with JICA's related projects were observed within the expected scope.

Therefore, its relevance and coherence are high.

3.2 Effectiveness and Impacts[11] (Rating: ③)

3.2.1 Effectiveness

3.2.1.1 Project Outputs

<Phase 1>

The achievement of the following three outcomes set for Phase 1 was as follows.

Output 1: The target villagers acquire knowledge and skills regarding productive activities including tree growing and soil erosion control. -> Generally achieved

Output 2: Capacity of the target villagers is enhanced to access necessary resources for productive activities including tree growing and soil erosion control. -> Generally achieved

Output 3: Capacity of the counterparts is enhanced in supporting productive activities including tree growing and soil erosion control. -> Achieved

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

Three to five indicators were set for each Output, and in the ex-post evaluation, it was decided that the achievement status of the Outputs at the time of project completion would be ascertained through the measurement of the achievement level of the indicators. However, it was difficult to confirm the level of achievement at the time of completion of Phase 1 (2012) in detail in the ex-post evaluation (2022) due to the absence of relevant personnel and lack of data of that time. The level of achievement was determined based on the assumption that the status of achievement at the time of the terminal evaluation, conducted a few months prior to the completion of Phase 1, remained mostly unchanged.

As for Output 2, the percentage of households that had access to information and resources (seedlings, etc.) necessary for production activities among the ones which participated in the training was set as an indicator, but the quantitative information on how many households actually had access to information and resources and were able to utilize them was difficult to obtain because no data were available. However, a qualitative survey conducted during the ex-post evaluation[12] confirmed that some resources were provided in all villages where the training was provided, suggesting that the indicator targets in terms of access to information and access to resources at the village level were generally achieved.

<Phase 2>

The following four Outputs were set for Phase 2, and all of them were confirmed to have been achieved at the completion of the project.

Output 1: Promotion for the target districts and the ministries concerned to ensure institutionalization and budget for COVAMS is carried out. -> Achieved

Output 2: Capacity for implementing the COVAMS approach by officers of the target districts is improved. -> Achieved

Output 3: Effectiveness of the COVAMS approach, both extension method and extension subject, is verified. -> Achieved

Output 4: The commitment of the COVAMS approach among leaders of all levels is enhanced. -> Achieved

Regarding Output 2, the degree of improvement in operational capacity was measured through self-assessment and mutual assessment to confirm the level of achievement, but

[12] A total of 35 villages were selected from the 11 TAs targeted in both projects, and 5 villages from the non-target TAs. Group interviews were conducted with about five representatives in each village (Senior lead farmers, lead farmers, and representatives of general farmers participated). The main survey items were: continuation status of CMFA, reforestation and conservation status, soil conservation status, improvement of agricultural productivity, livelihood improvement, improvement of women's social and economic status, impact on the natural environment, and land acquisition and resettlement.

quantitative evaluation results could not be confirmed. This was due to the fact that the COVAMS approach itself focused on the rapid dissemination of simple technologies and did not place emphasis on monitoring the implementation status. The criteria for certification as a lead farmer (LF) were also qualitative, with certification granted only if the farmer was deemed to have mastered the technology through attending on-site training sessions. Therefore, there was no quantitative criteria for measuring the improved capacities, but it is considered that the government officers' operational capacity was steadily improved through repeated instruction of simple techniques in a large number of villages.

Regarding Output 4, project stakeholder meetings were held monthly at the district level, and general meetings of stakeholders from the four districts were held once or twice a year, indicating that the commitment of the stakeholders was strengthened during the project period.

3.2.1.2 Achievement of Project Purpose

In both projects, it was assumed that the Project Purpose would also be met through the achievement of Outputs. The Project Purpose, indicators, and the actual outcomes for each phase are shown in Table 2.

Table 2: Achievement of Project Purpose

Project Purpose	Indicator	Actual
<Phase 1> Productive activities including tree growing and soil erosion control are implemented with consideration of forest conservation and rehabilitation in the target villages.	Indicator 1: Percentage of households adopting recommended tree growing techniques to the total number of households (50% in 50 villages, 30% in 119 villages and 20% in 75 villages)	Indicator 1: By the time of the Terminal Evaluation, the percentage of households that had adopted tree growing techniques reached 78.1% in 50 villages, 76.1% in 119 villages, and 67.9% in 75 villages.
	Indicator 2: Percentage of households adopting recommended soil erosion control techniques to the total number of households (50% in 50 villages, 30% in 119 villages and 20% in 75 villages)	Indicator 2: The percentage of households that had adopted soil erosion control techniques as of project completion (November 2012) was 52.5% in 50 villages, 39.5% in 119 villages, and 21.7% in 75 villages.
	Indicator 3: Percentage of households practicing other productive activities to the total number of households (30% in 9 villages covered by the Integrated Village Training Approach (IVTA)	Indicator 3: Converted from Integrated Village Training Approach (IVTA) to Specific Village Training Approach (SVTA) during project implementation; IVTA was implemented in 7 villages. As of the Mid-term Review (June 2010), 100% was achieved in the seven IVTA villages.
<Phase 2> CMFA through COVAMS approach is institutionalized in the target districts.	Indicator 1: The annual plan and the budget request for CMFA using the COVAMS approach are prepared and implemented by the district departments.	Indicator 1: The activities plan was prepared for the 2017/18 and 2018/19 fiscal years. The Action Plan[13] aiming to achieve the Overall Goal of COVAMS was prepared.
	Indicator 2: The guidelines for the COVAMS approach is acknowledged by ministries concerned.	Indicator 2: Guidelines and manuals for the COVAMS approach were prepared in 2018 and formally endorsed by the counterpart and cooperating agencies.

Source: Terminal Evaluation Report of Phase 1, Response to the ex-post evaluation questionnaire, Project Completion Report of Phase 2

<Phase 1>

The "Output" was generally achieved as a whole, as the residents in the target areas acquired knowledge and skills in various production activities, including tree growing and soil erosion control, and access to necessary resources, while the support capacity of government officials and extension workers was also improved. The Project Purpose can be said to have been achieved as the three indicators set for the Project Purpose were all achieved.

<Phase 2>

The Project Purpose is considered to have been achieved by the time of completion, as both of the two indicators set were achieved. Moreover, for Outputs 1-4, the management

[13] The Action Plan consisted of five items: i) follow-up in COVAMS II villages, ii) dissemination of Lean COVAMS, iii) expansion of CMFA, iv) CMFA at primary schools, and v) list of future donors and partners. At the completion of Phase 2, the plan was expected to be implemented in each province for three years after the completion.

capacity of those involved was improved, dissemination methods and techniques were established, lobbying for institutionalization were carried out, and the commitment of the people involved was strengthened.

Since it was clear that the achievement of Outputs in both Phase 1 and Phase 2 would lead to the achievement of the Project Purpose, and since the indicators of the Project Purpose in each phase were also the necessary elements for the achievement of the Purpose, the level of achievement of the Project Purpose was verified from both perspectives. Some of the indicators for the Project Purpose and Outputs were “output” indicators that could be achieved only by implementing the activities. Therefore, there was an aspect where it was not clear to what extent the capacity of the implementing agency and the target villages to independently implement the project had actually improved. However, it was confirmed as a whole that the Outputs were generally achieved and the Project Purposes were also achieved in both phases.

3.2.2 Impacts

3.2.2.1 Achievement of Overall Goal

The Overall Goal of Phase 1 is “Villagers in the target villages practice sustainable forest management (including soil conservation) through the improvement of livelihoods.” The Overall Goal for Phase 2 was “Catchment management through farmers' activities using COVAMS approach is widely implemented in the target districts.” Phase 1 was a project targeting two TAs in Blantyre District, and Phase 2 was an expansion of the efforts to a total of nine TAs in four districts, including Blantyre District. Since the contents of the Overall Goal of Phase 1 were considered to be contained in the contents of the Overall Goal of Phase 2, the Overall Goal of Phase 2 was used as the one for the two projects in this ex-post evaluation, and its measurement indicators were six in total set for Phase 1 and Phase 2.

Table 3: Achievement of Overall Goal

Overall Goal	Indicator	Actual
Overall Goal "Catchment management through farmers' activities using COVAMS approach is widely implemented in the target districts."	Indicator 1: Percentage of households who recognize improvement in the outlook of trees and access to forest products in the 244 target villages (60%)	Indicator 1: The percentage of households was unknown due to lack of data, but according to the Blantyre District Office of the Department of Forestry, views of trees have improved significantly and access to forest products also improved to some extent. Specifically, only 6,000 seedlings were planted in the project area in 2007, but in 2015, 274,350 trees were planted, of which 136,082 were growing. In addition, a total of seven cases of beekeeping, fruit production, and log production, which did not exist in 2007, were identified.
	Indicator 2: Percentage of households of which the livelihood is improved in the 244 target villages (60%)	Indicator 2: According to the Blantyre District Office, livelihoods in the target villages improved significantly. Increased agricultural production due to soil conservation and increased income from forest product sales were the main areas of improvement. The area planted with maize increased by 14% from 2007 to 2015, and production increased by 14%. Interviews with a total of 20 people in four villages in the target two TAs revealed that in all villages, vegetable cultivation stabilized using the techniques introduced by the project, such as soil conservation and contour farming, which led to an increase in income. In addition, the number of trees in the villages increased through afforestation, which facilitated the more convenient use of firewood.
	Indicator 3: Percentage of households adopting recommended tree growing techniques to the total number of households in the 244 target villages (60%)	Indicator 3: Nurseries were established and reforestation activities were conducted in several of the villages visited, and some villages were active, but not many villages continued their activities after the project was completed (even within the villages, there was a mix of farmers who continued and those who stopped). Although the benefits of the trees planted during the project period were enjoyed in the form of easier access to firewood and as windbreaks, afforestation activities were not necessarily widespread due to the lack of sufficient funds to purchase seedlings, machinery and so on.
	Indicator 4: Percentage of households adopting recommended soil erosion control techniques to the total number of households in the 244 target villages (60%)	Indicator 4: According to the district offices, although no data on the percentage of households was available, the technology was also employed in Phase 2 and continued to show significant expansion in the two TAs covered under Phase 1.
	Indicator 5: CMFA using COVAMS approach implemented in at least two TAs other than the target districts	Indicator 5: According to the district offices, COVAMS/Lean COVAMS were practiced in villages in one TA in Blantyre, two villages in Neno, six villages in Mwanza, and two TAs in Balaka districts.
	Indicator 6: CMFA using COVAMS approach adopted by at least one project funded by other donors in the target districts	Indicator 6: Some of the techniques introduced in COVAMS were used in the UN World Food Program's Adaptation Fund Project (2021-2025) and the Malawi Youth Afforestation Program (2018-2020) of the Government of Malawi.

Note: Indicators 1-4 are for Phase 1 (target year: 2015); Indicators 5-6 are for Phase 2 (target year: 2021)
Source: Prepared based on the responses to the ex-post evaluation questionnaire and results of interviews with the implementing agency

Although it was difficult to quantitatively demonstrate the achievement of the indicators as the data necessary for the ex-post evaluation was not fully developed, it can be said as a whole that the following impacts and challenges were observed.

In 2015, the target year for Phase 1, Phase 2 was underway and the COVAMS approach was expanding in the target districts. There were examples of soil conservation and other techniques being applied as well as the utilization of extension workers with improved capacities in the projects supported by other donors.

In the villages that actually received assistance, many farmers continued to engage in production activities using the techniques they had learned through the training. As a result of the stabilization of the soil in the fields through seedling cultivation, afforestation, and contour farming, the increased production led to the stable securing of vegetables and increased sales. It was confirmed that the actual economic benefits felt in this way were the major driving factor for the continuation of activities, and it can be said that this was a major contribution of this project to the rural communities.

However, with the completion of this project, support for CMFA activities in the target TAs was not continued by the Department of Forestry, and there was almost no expansion of activities to non-target TAs in the neighboring areas. One of the major reasons for this is the budget shortage of the Department of Forestry, which made it difficult to provide intensive support in the form that was implemented in this project, and the promotion system became the one in which extension workers occasionally provided guidance on some technologies as part of their regular extension activities. In the non-target TAs, even though they knew that the farmers in the target TAs were enjoying significant economic benefits, they were not able to initiate CMFA because they lacked the funds to make the initial investment and the visits of extension workers who could provide technical guidance.

In this way, CMFA is practically limited to activities by farmers in the villages of the TAs supported by the project, and has not been widely implemented in the target districts. As a result, as shown in Box below, the satellite data analysis did not show any impacts on the forest increase or slowdown in deforestation in the target area. On the other hand, the indicators for the Overall Goal were achieved to a certain extent, suggesting that the project generated some impacts.

Box 1　Analysis of the project's effect on the forest area using satellite data

In this ex-post evaluation, the project's effects on the forest increase (or slowdown in deforestation) are examined using satellite data[14]. The analysis compares changes in the forest area[15] at the TA level between the 11 target TAs and the 31 non-target TAs[16] and examines the difference (effect) between the two groups. The areas covered by the analysis are shown in Figure 2.

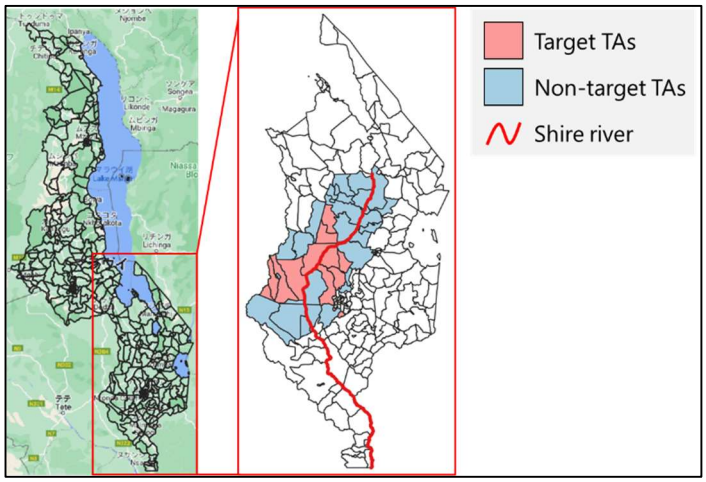
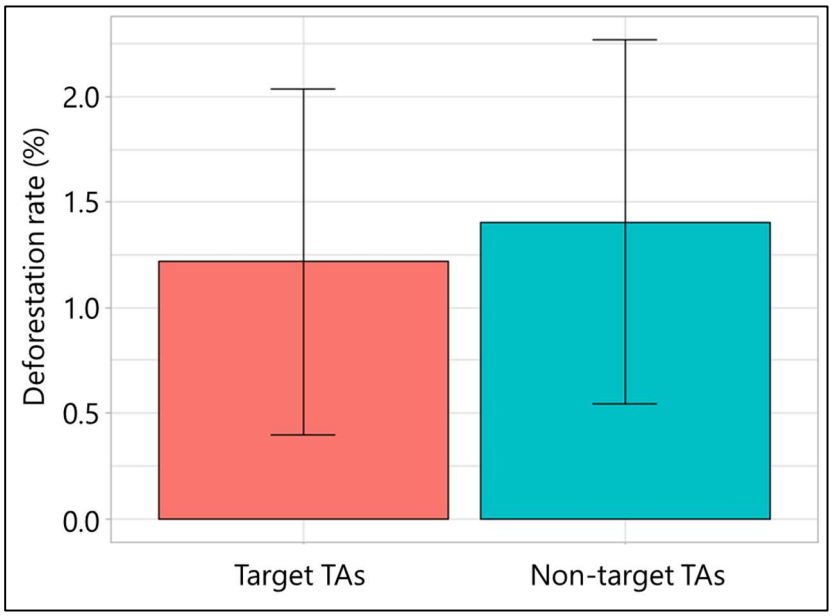


Figure 2 Project area

Figure 3 shows the results of the analysis of deforestation rates from 2000 to 2021 based on Hansen Global Forest Change data. It shows that deforestation rates for both the target and non-target TAs are 1.0-1.5%. There is no statistically significant difference between the two groups, indicating that both groups experienced the same level of deforestation. Figure 4 shows the percentage of the forest area from 2001 to 2020 based on the MODIS Land Cover Type data. Since 2007, when Phase 1 began, the forest area has remained almost the same in the target TAs, while it has decreased by about one percentage point in the non-target TAs. However, the difference between the two changes is not statistically significant. Based on these results, it cannot be concluded that the forest area increased (or deforestation was slowed down) more in the target TAs than in the non-target TAs. The result suggests that the afforestation conducted in this project was not on a scale that would allow the changes to be captured by satellite data.

[14] In addition to the effect on forest area, the project's effects on field area, water area, and improved soil area are also examined. These results are shown in Box 2 at the end of this report.
[15] The data from two sources are used in the analysis: Hansen Global Forest Change v1.9 (the difference between 2000 and 2021, approximately 30m resolution) and MODIS Land Cover Type Yearly Global 500m (From 2001 to 2020, approximately 500m resolution).
[16] To make appropriate comparisons, it is necessary to select non-target TAs similar to the target TAs in terms of the natural environment, etc. Therefore, (1) non-target TAs (19 TAs) in the same prefecture (district) as the target TA and (2) non-target TAs (12 TAs) adjacent to the target TA even if they are different prefectures were selected as "non-target TAs" (31 TAs in total).



Note: The vertical lines on the bars show the confidence interval at the 95% level.

Figure 3 Comparison of deforestation rate (change from 2000 to 2021)

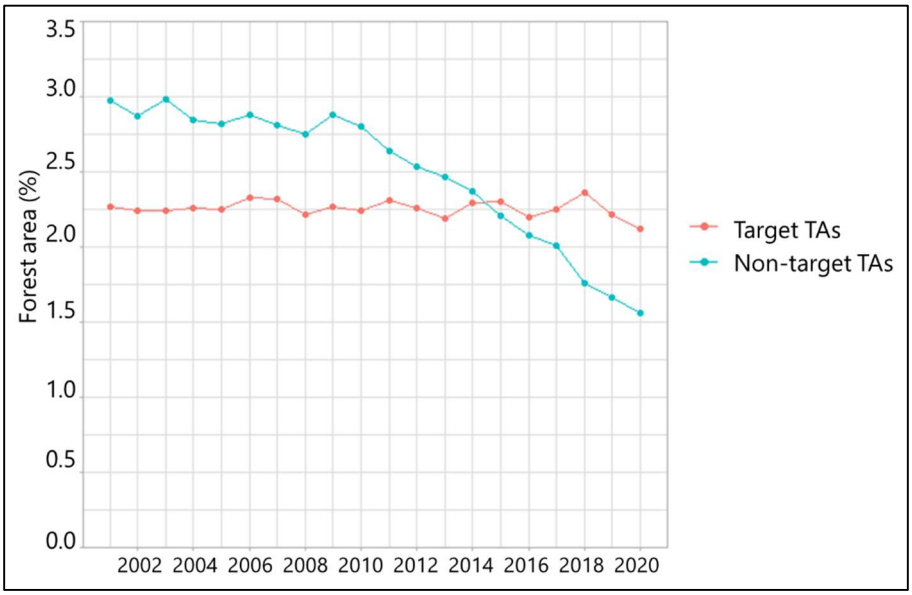


Figure 4 Trends in forest area (2001-2020)

As a result of the above, it is judged as a whole that the Overall Goal was achieved to a certain extent compared to the plan.

New seedlings planted after the completion of the project
(Source: External Evaluator)

A house rebuilt with improved income
(Source: External Evaluator)

3.2.2.2 Achievement Status of Overall Goal at the Time of Ex-post Evaluation

In the ex-post evaluation, the status of the Project Purpose that was confirmed at the time of project completion in "3.2.1 Effectiveness" was checked and analyzed at the time of ex-post evaluation. The results were mainly as follows.

<Phase 1: Project Purpose - Productive activities including tree growing and soil erosion control are implemented with consideration of forest conservation and rehabilitation in the target villages.>

The various production activities mainly fall into the categories of tree growing, soil erosion control, and gully repair. In each of these areas, the qualitative survey confirmed that the following activities were being implemented continuously in most of the target villages and continued to bring economic benefits to the farmers.

- Tree growing: tree growing activities, beekeeping, securing fuel wood and building materials in the village, and growing and maintaining windbreaks.
- Soil erosion control: reduction of erosion cases, maintenance of soil nutrients, and increased crop production
- Gully repair: restoration of land that had been eroded, reduction of siltation in rivers, increased crop production

<Phase 2: Project Purpose - CMFA through COVAMS approach is institutionalized in the target districts.>

CMFA was planned in the annual plan by the completion of the project, and (1) target villages of the project would be followed up (4 districts), (2) Lean COVAMS would be disseminated (1 district), (3) CMFA would be expanded (3 districts), and (4) CMFA would be implemented in elementary school (2 districts). The status of their implementation was confirmed as follows after the completion of the project.

(1) Target villages were followed up in 3 districts other than Balaka District.
(2) Lean COVAMS was implemented in Mwanza District.
(3) CMFA was expanded in Mwanza and Neno Districts (not implemented in Balaka District)
(4) CMFA was implemented in elementary schools (tree planting and learning about agroforestry) in Mwanza and Neno Districts.

Activities related to CMFA were not implemented at all in Balaka District due to the lack of budget. It was confirmed that the manuals and guidelines prepared in this project were being utilized by extension workers and LFs in each district. However, these manuals and guidelines were not updated due to the lack of budget.

As a whole, it was confirmed that farmers in the target villages of the project realized the benefits of the project. Although there are differences in the degree of implementation from village to village, it can be said that CMFA activities have generally been continued. In Phase 2, CMFA activities were included in the annual plan, with the intention of continuing to strengthen and disseminate the COVAMS approach in the target districts after its completion, and these activities were initially implemented in all but Balaka districts, as mentioned above. However, after 2019, the COVAMS approach has no longer been explicitly continued as an activity in each district. The main reason is the lack of budget, and at the time of ex-post evaluation, the reality is that the extension workers share their knowledge and provide guidance on the COVAMS approach during their visits to villages. While the target TAs of the project showed the continuity in their activities, it was difficult for non-target TAs to start new activities by providing new seedlings and farming tools, and CMFA through the COVAMS approach has not yet been fully institutionalized and implemented continuously.

3.2.2.3 Other Positive and Negative Impacts

1) Impacts on the Natural Environment

Phase 1 was considered to have no adverse impacts on the environment and no categorization based on the Guidelines for the Confirmation of Environmental and Social

Consideration was given. Phase 2 was considered to have minimal or no undesirable impacts on the environment and society as it would implement catchment conservation activities conducive to the conservation of the natural environment, and was categorized as Category C in the "Guidelines for Environmental and Social Considerations" (formulated in April 2010).

According to the information provided by the implementing agency and the results of the qualitative survey, the activities of the two projects promoted positive impacts on the natural environment, such as the restoration of forest areas and prevention of soil runoff, and no negative impacts occurred as a result of the implementation of the projects.

Therefore, it is concluded that both projects had positive impacts on the natural environment.

2) Resettlement and Land Acquisition

Resettlement and land acquisition associated with the implementation of both projects were not expected at the time of planning, and in fact, no case was confirmed in which resettlement or land acquisition occurred as a result of the implementation of the projects.

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

In Phase 1, the introduction of production activities targeted at women was envisaged at the time of planning, and it was planned to promote women's participation and involvement. In Phase 2, it was also assumed that gender balance and progress on gender indicators would be kept in mind when planning and monitoring LF selection and training activities.

In fact, in both projects, LFs were selected from all residents of the target villages as originally planned, and no gender distinction was made. Although specific data were not available, the qualitative survey confirmed that more women participated in training and other activities in all villages and that they fully participated in the decision-making process in the villages, and several cases were also heard that women became able to start keeping livestock. Therefore, it can be said that women played a major role in both projects and that both projects had a sufficient impact on the gender aspect.

Regarding equitable participation in the project in the target villages, both projects were open to all households, and it was up to each farmer to decide whether or not to participate. Therefore, no one was prevented from equitable participation. In addition, the livelihood gains were not biased toward any particular group, so it can be said that both projects were implemented appropriately and had positive impacts.

Although it was difficult to measure the impact of the projects on social systems, norms, and people's well-being in the villages as a whole, livelihoods were improved at the individual and village levels through the implementation of the projects, and even in villages where the economic benefits of the project were not so great, some farmers said that before the project, there were times when they did not have enough to eat, but after the project, they no longer had problems securing food due to increased agricultural production at least. It is considered that the project improved the sense of security of each farming household.

4) Unintended Positive/Negative Impacts

When both projects were planned, it was pointed out that the sediment discharged from the project areas flowed into Shire River and pushed up the riverbed, triggering massive sediment deposition at several dams and reducing the generating capacity of hydroelectric power plants, Malawi's main power source. The actual amount of electricity generated on Shire River and its percentage of Malawi's total electricity generation were as follows.

Table 4: Power Generation in the Shire River System and Share of Power Generation in the Country

Fiscal Year	2007/08	2012/13	2017/18	2018/19	2019/20	2020/21
Amount of electricity generated (GWh)	1,517	1,821	1,656	1,728	1,664	2,033
Percentage of electricity generated (%)	98.0	99.0	97.6	97.1	95.8	97.4

Source: Information provided by the Electricity Generation Company Limited (EGENCO)

It was not possible to determine from the power generation data the extent to which the reduction in power generation capacity due to the pushing up of the river bed had occurred. However, for the Electricity Generation Company Limited (hereinafter referred to as "EGENCO"), one of the major challenges they were facing was the sediment deposition in Shire River due to deforestation and other factors. In Malawi, where thermal power generation is used only in emergency situations, power generation from the Shire River system has always been very important, accounting for more than 95% of the country's total power generation. Therefore, EGENCO has been conducting its own annual reforestation program to improve the watershed environment and to educate the community: 18,286 trees were planted in the Shire River basin in FY 2018/19 and 8,197 trees in FY 2019/20, as well as donating necessary equipment to the corresponding villages. These efforts are complementing the effects of the two JICA-supported projects.

The overall impacts of the two projects can be summarized as follows.

The benefits of CMFA were generally strongly felt in the target villages, and the activities were generally continued at the time of ex-post evaluation. On the other hand, CMFA has not been expanded to non-target villages, and it was confirmed that CMFA has not yet been widely disseminated in the target districts. The project had positive impacts on the natural environment, and there were no problems with resettlement or land acquisition. In addition, it was confirmed that the two projects had positive impacts on other social aspects, and as a whole, there were no negative impacts in terms of environmental and social considerations.

The Project Purpose and the Outputs of the project were generally achieved, and the effectiveness of the project was judged to be high. On the other hand, the generated effects were limited to the target areas, and the dissemination to non-target areas was limited, so it could not be said that the Overall Goals was fully achieved. However, except for the expansion to non-target areas after the completion of the project, other targets were generally achieved, and the effectiveness and impacts of the project as a whole are judged to be high.

3.3 Efficiency (Rating: ③)

3.3.1 Inputs

The planned and actual inputs of both projects are shown in Table 5.

Table 5: Planned and Actual Inputs of Both Projects

	Inputs	Plan	Actual (at project completion)
Phase 1	(1) Dispatch of experts	4 Long-term 1 Short-term	3 Long-term 2 Short-term
	(2) Trainees received	Unknown	29 persons (12 in a third country, 17 in Japan)
	(3) Provision of equipment	Vehicle, Motorbike, Training equipment	Vehicle, Motorbike, Training equipment
	(4) Local activity cost	Unknown (Expenses for seminars, etc.)	41 million yen (Expenses for seminars, etc.)
	Japanese side Total project cost	381 million yen in total	401 million yen in total
	Malawian side Total project cost	50 million yen in total	Unknown
	Inputs	Plan	Actual (at project completion)
Phase 2	(1) Dispatch of experts	4 Long-term 1 Short-term	3 Long-term 15 Short-term
	(2) Trainees received	Unknown	30 persons
	(3) Provision of equipment	Vehicle, Motorbike, Training equipment	Vehicle, Motorbike, Training equipment
	(4) Overseas project enhancement cost	124 million yen	Unknown
	Japanese side Total project cost	504 million yen in total	538million yen in total
	Malawian side Total project cost	50 million yen in total	Unknown

Source: Ex-ante Evaluation Paper (both projects), Inception Report (Phase 1), Terminal Evaluation Report (Phase 1), Project Completion Report (Phase 2), Materials provided by JICA

3.3.1.1 Elements of Inputs

Although it was difficult to compare the planned and actual inputs for Phase 1 due to uncertainties in the content at the time of planning, the long-term and short-term experts were dispatched to provide routine training and instructions, while providing equipment necessary for training and inviting them to participate in the training programs in third countries and Japan. In light of the achievement status of the Outputs and Project Purpose, the activities and the input elements for those activities were largely in line with the expectations.

As for Phase 2, the number of short-term experts increased significantly, but this was due to the fact that the implementation structure, which was mainly conducted by long-term experts in the first half of Phase 2, was changed to the implementation by a consultant team of short-term experts in the second half.

3.3.1.2 Project Cost

The actual amount of Phase 1 and Phase 2 was 105% and 107% of the plan respectively, exceeding the planned amount, and the total amount of both projects was 106% of the plan. Although the detailed reasons for exceeding the planned amount were unknown, securing transportation for the experts and extension workers to conduct the training was a very important factor since both projects covered many villages in a vast area. According to the experts in the second half of Phase 2, a lot of expenses were needed to secure repair and maintenance costs for a large number of vehicles and motorcycles, as well as fuel costs, from the beginning of Phase 1.

3.3.1.3 Project Period

Phase 1 was implemented for 5 years from November 2007 to November 2012, and Phase 2 was implemented for 5 years from April 2013 to March 2018. Both of these project periods were in line with the plan (100% of the plan for both).

Based on the above, the overall efficiency of the two projects is high, as the project periods of both projects were within the plan while the project costs of both slightly exceeded the plan.

3.4 Sustainability (Rating: ②)

3.4.1 Policy and System

The *Malawi 2063 First 10-Year Implementation Plan (MIP-1)* (2021-2030) refers to the promotion of agroforestry and forest conservation. The *National Forest Policy* (2016-2021) also identifies community-based forest management as one of the policy priority areas under the goal of restoring the forest coverage rate. In this way, since the completion of Phase 2, the importance of forest management has been consistently mentioned in both the national and sector plans. The sector plan also emphasizes community-based forest management and identifies the Department of Forestry as the organization responsible for its implementation. However, despite the importance of community-based forest management, there is no reference to specific measures on how to position CMFA, and the sustainability of the policy and system is not necessarily high.

3.4.2 Institutional/Organizational Aspect

In each of the target districts, the project implementation structure consists of a District Management Team (DMT), under which is a Technical Support Team (TST), and under which is a Conservation Coordination Officer (CCO). For example, in Blantyre District, there were five members in DMT, five in TST, and eight CCOs in the entire district, with the CCOs providing guidance to senior lead farmers (SLFs) and LFs in each village, and

SLFs and LFs conducting the transfer of techniques to their members in the villages.

This dissemination system was formally existing at the time of ex-post evaluation, as it was during project implementation. However, since CMFA using the COVAMS approach was not conducted after the project was completed, regular meetings were not held at the district level, and the system was not practically functioning. In addition, many CCOs did not have the means of transportation such as motorcycles, and the budget for purchasing petrol was limited, and visiting each village was generally not an easy task. On the other hand, in each of the villages targeted by the project, SLFs and LFs had the knowledge to provide guidance to other farmers in the village through the implementation of the project, and they actually provided consultation and guidance as needed. In each village, the SLFs and LFs appeared to be fulfilling certain functions.

Therefore, although the organization and structure exist, they cannot be considered to be functioning effectively and there are certain sustainability issues because they have not been able to implement activities related to further dissemination of the outcomes of both projects.

3.4.3 Technical Aspect

DMT members have the ability to develop annual plans and oversee activities; TST has the ability to prepare reporting documents to DMT and provide technical guidance and monitoring to CCOs, while CCOs primarily provide technical guidance to SLFs and LFs.

During the implementation of the project, the trained CCOs provided guidance on CMFA to SLFs and LFs, and they have certain skills based on their experience in introducing them in the target villages. However, after 2019, budgetary measures have not been taken and dissemination activities have not been conducted as they were during project implementation. There are also concerns about the succession of technical skills, as the CCOs involved in the project are gradually beginning to retire. The CCOs also visit non-target villages, but often for other purposes, such as the maintenance of irrigation facilities, making it difficult to allocate sufficient time to provide guidance on CMFA.

As described above, DMT, TST and CCO have certain capabilities, and CCOs have the knowledge to guide SLFs and LFs in their respective villages, but they have not been able to further disseminate CMFAs using the COVAMS approach, and the technical capabilities they have are not being utilized continually.

3.4.4 Financial Aspect

The general budget allocations to each of the targeted district forestry offices for FY 2019/20 and beyond were as follows.

Table 6: General Budget of Each District Forestry Office

(Unit: thousand kwacha)

District	FY 2019/20	FY 2020/21	FY 2021/22
Blantyre	7,000	5,000	10,000
Mwanza	5,000	6,000	15,000
Balaka	4,000	3,000	3,000
Neno	3,100	6,000	9,000

Note: 1 kwacha = approximately 0.13 yen (July 2022)
Source: Data provided by the Southern Region Office of the Department of Forestry

Each district does not have a budget allocated specifically for the promotion of CMFA, and although there is an increasing trend, the need to conduct various activities with a very limited budget has arisen. This is a major constraint preventing the continuation of activities conducted under the project. As mentioned above, EGENCO supports some activities such as tree planting, but there is no financial support from donors or NGOs.

Therefore, it can be said that the financial constraints are the major challenge for the continuation of the project effects.

3.4.5 Environmental and Social Aspect

As a result of discussions with the implementing agency, qualitative survey, and site survey, no negative impacts in terms of environmental and social considerations were identified at the time of ex-post evaluation. It can be judged that there are no particular concerns.

3.4.6 Preventative Measures to Risks

Other than the sustainability issues described above, no specific risks were identified that became evident during the implementation or after the completion of the project.

In sustaining the outcomes of the two projects, there were some issues in terms of policy and system as well as significant financial challenges that prevented further strengthening of CMFA in the target villages and continued expansion to non-target villages. Therefore, it could not be said that the promotion system and the techniques possessed by those involved that existed after the completion of the project were fully utilized. In order to widely disseminate CMFA, in addition to the increases in the overall budget for each district office, a higher priority and specialized budget allocation for CMFA activities will be required, which will be highly difficult to achieve in the short term. No particular challenges were identified in terms of environmental and social considerations and response to risks.

Therefore, the sustainability of the project effects is moderately low.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The “Project for Community Vitalization and Afforestation in Middle Shire” and the “Project for Promoting Catchment Management Activities in Middle Shire” as a whole aimed to improve the livelihoods through sustainable forest resource management by village farmers in the southern region of Malawi, where the forest area had significantly decreased. Both projects were consistent with Malawi's development plans and needs at the time of planning and completion, and with Japan's ODA policy at the time of planning. In addition, while there was limited coordination with the support by other organizations, there were synergies observed with JICA's related projects and within the expected scope. Therefore, the relevance and coherence of this project is high. The Project Purposes and the Outputs of both projects were generally achieved, and while the effects were widely seen in the areas targeted by the projects, their expansion to other areas was limited, and the Overall Goals were not fully achieved. However, the effectiveness and impacts of the two projects as a whole are high, as the direct support provided by the project was highly effective. The overall efficiency of the project was judged to be high, since the project period was within the planned period while the project cost exceeded the planned amount for both projects. Regarding the sustainability of the effects generated through the two projects, there were some issues in terms of policies and systems, as well as major financial issues, and it was confirmed that the technology was not fully utilized. Therefore, the sustainability of the project is moderately low.

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

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

Many of the target villages supported by the project continued their CMFA activities at the time of ex-post evaluation. This is largely due to the fact that the agricultural production through afforestation and soil conservation activities stabilized, and the villages came to realize the economic benefits of not only securing vegetables for their own consumption, but also having the produce that could be sold in the market. In the COVAMS approach, all households were equally targeted for support in the village areas, and the CCOs provided guidance to SLFs and LFs, who then disseminated to farmers in each village, while utilizing on-site resources as much as possible. This is a form of implementation that can be applied to other regions. The expansion to other regions through such an approach will help revitalize the economy of rural Malawi and solve poverty issues. Therefore, it is important to further enhance the policy position of rural development through commercial farming and give priority to budget allocation or secure external funding from donors and

other sources.

4.2.2 Recommendations to JICA

Although CMFA based on the COVAMS approach had not been expanded to other areas at the time of ex-post evaluation, it functioned effectively in the target areas directly supported by this project and brought about improvements in the economic and social conditions in rural areas. Therefore, when implementing projects in the field of rural development in Malawi, it would be beneficial to incorporate the approach and components of this project as much as possible, and to encourage the government to reflect in its policies the COVAMS approach that clarifies the specific positioning of watershed management by communities, which was not realized in this project.

4.3 Lessons Learned

Importance of establishing policy positions and securing budgets to continue the project activities

Japan's support for rural development in the southern region of Malawi began with a forest conservation survey in the late 1990s and continued for nearly 20 years until the completion of Phase 2, which promoted watershed management and village development in the Middle Shire. Through the implementation of both projects, the livelihoods of the target villages were improved, and the projects can be evaluated as the ones which had a significant impact. On the other hand, after the completion of Phase 2, the government of Malawi did not actively continue the activities and did not expand them to the surrounding areas. The main reason for this was the lack of budget at the district forest offices responsible for implementing the activities, and the sustainability of the project effects was not ensured under the circumstances of insufficient funds for the activities. This is not an issue that can be easily resolved in countries where the overall government budget is not large or where there are many other development issues. When providing support in the agriculture and forestry sector, it is necessary to ensure a sufficient project period, consider how to secure funds after the project completion, and establish a financial framework to ensure the continuation of the activities (This would include the enhancement of policy priorities to sustainably increase the budget amount, and the enhancement of the capacity of those involved to generate outcomes and further proposals that will always receive support from other donors and NGOs). It would be desirable to consider the prospect of securing budgets when planning projects, and to include support for building such a framework in project activities during implementation.

5. Non-Score Criteria

5.1. Performance

5.1.1 Objective Perspective

JICA began supporting watershed management and village development through forest conservation in Malawi in the late 1990s, and while maintaining a good relationship with the Department of Forestry, the implementation of both COVAMS phases was realized.

The project experts also established a project implementation system with a view to future development, and through collaboration with relevant stakeholders, it can be said that CMFA could be introduced in many villages through the COVAMS approach, and that JICA was also able to appropriately monitor the implementation of the project. In particular, the concrete outcomes observed in the target villages through Phase 1 led to the active involvement of the implementing agency officials in dissemination activities in Phase 2, which facilitated the smooth implementation of the project activities over a wide range of villages. This can be seen as an example of a virtuous circle in which the project stakeholders found the significance of the project and became more actively involved as the outcomes emerged through years of cooperation.

5.2. Additionality

None

Box 2 Other Analyses using satellite data

In addition to analyzing the effects on the forest area shown in Box 1, this ex-post evaluation also used satellite data to analyze the project's effects on the field area, water area, and improved soil area[17]. The same methodology as in Box 1 is used for these analyses.

The results of the analysis for each outcome are as follows. No significant effect of the project is confirmed for any of the outcomes.

Field area: Figure 5 shows the change in cultivated land area (%) from 2001 to 2020, as estimated based on the MODIS Land Cover Type. Although the cultivated land area tends to be larger in the non-target TAs than in the target TAs for the entire period, the trends for both TAs are almost similar. Since 2007, when Phase 1 began, the area has not increased in the target TAs but has been decreasing, as in the non-target TAs. Therefore, it cannot be concluded that there has been a positive impact on the cultivated land.

[17] The following data are used:

- Field area: MODIS Land Cover Type Yearly Global 500 m (From 2001 to 2020, approximately 500m resolution)
- Water area: JRC Yearly Water Classification History, v1.3 (From 2001 to 2021, approximately 30m resolution)
- Improved soil land: TRENDS.EARTH（the difference between 2007 and 2020, approximately 250m resolution） If the quantity of soil organic carbon increases, the area is defined as "improved soil area."

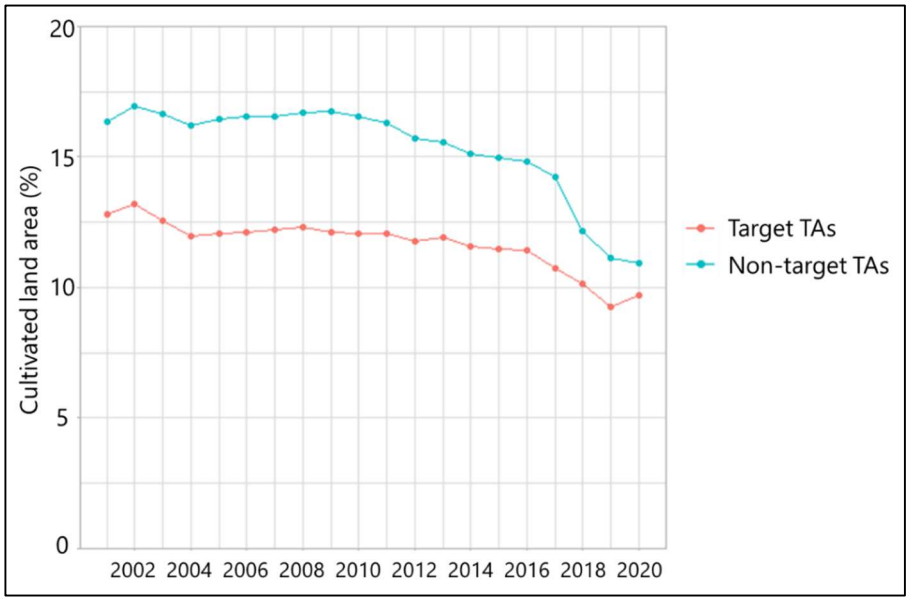


Figure 5: Trends in Cultivated Land Area (2001-2020)

Water Area: Figure 6 shows the change in water area (%) from 2000 to 2020, estimated based on the JRC Yearly Water Classification. For both the target TAs and non-target TAs, the water area is constant over the long term, and no change is observed before and after the project. Therefore, it cannot be concluded that there was a positive impact on the water area of water bodies. On the other hand, regarding soil runoff, it cannot be said that there was a negative impact on a scale that could affect the size of the water area.

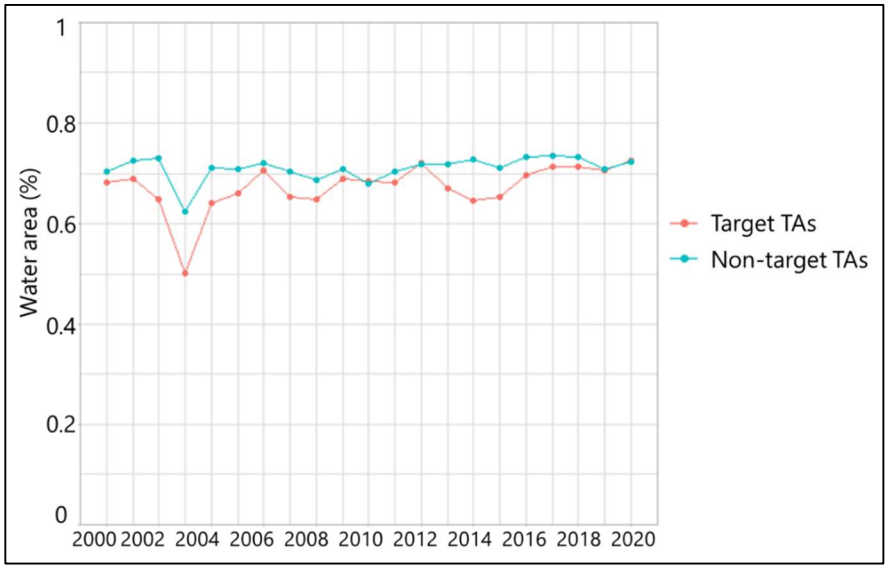
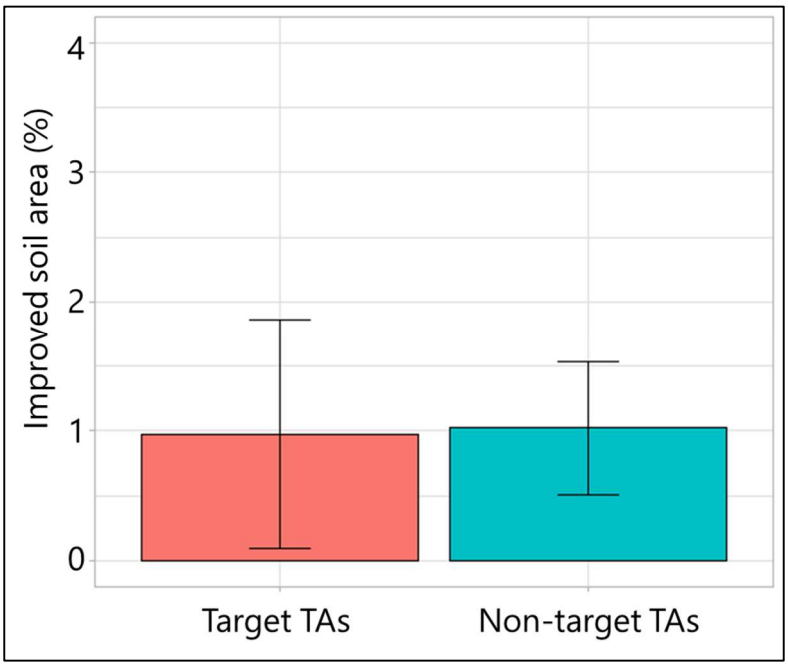


Figure 6: Trends in water area (2000-2020)

Soil Improvement: Figure 7 shows the changes in improved soil area (%) from 2007 to 2020, as estimated based on TRENDS.EARTH. Here, "improved soil" is defined as land with

increased soil organic carbon, an indicator of soil health. Figure 6 shows that the percentage of soil that improved between 2007, when Phase 1 began, and 2020 was about 1% for both the target and non-target TAs, and no difference was observed. Therefore, it cannot be concluded that there was a positive impact on soil improvement.



Note: The vertical lines on the bars show the confidence interval at the 95% level.

Figure 7: Comparison of improved soil area (change from 2007 to 2020)

(End)