

## FY2022 Simplified Ex-Post Evaluation Report of Japanese Grant Aid Project

External Evaluator: Kenichi Inazawa, Octavia Japan, Co., Ltd.

Duration of the Study: November 2022-January 2024

Duration of the Field Study: February-March 2023

Country Name The Islamic Republic of Pakistan	<b>The Project for Establishment of Specialized Medium Range Weather Forecasting Center and Strengthening of Weather Forecasting System</b>
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Locations of the Project Sites<sup>1</sup>Developed Meteorological Radar Tower (Inside Pakistan Meteorological Department Islamabad Head Office)  
(Source: picture taken by the evaluator)**I. Project Outline**

Background	<p>After the Kashmir earthquake (October 2005) which led to approximately 75,000 casualties, the Pakistani government drastically reviewed its conventional disaster countermeasures, which had traditionally been centered on post-disaster responses. More specifically, the National Disaster Management Ordinance was ratified and the National Disaster Management Authority (NDMA) was established as the center of disaster prevention administration, with a view to strengthening the disaster prevention system through a focus on prevention and damage mitigation. However, large-scale disasters such as the Indus River flood (2010) and the Sindh floods (2011) occurred one after another, which necessitated the establishment of a drastic disaster management system. To minimize damage, advanced flood forecasting and warning was needed based on regular meteorological observation and forecasting capabilities. The government established the Specialized Medium Range Weather Forecasting Center (hereinafter referred to as “SMRFC”) within the Pakistan Meteorological Department (hereinafter referred to as “PMD”), with the aim to improve the accuracy of short-range (within 24 hours) weather forecasts and the capacity of medium-range (over 48 hours) weather forecasts. As it had just been established, the SMRFC did not have sufficient equipment for weather forecasting analyses to serve its purposes. The meteorological radar system continued to malfunction because it was aging and there was a possibility that it would stop operating within a few years. Therefore, updating the radar system was an urgent issue.</p>
Objectives of the Project	<p>The objective of this project is to improve the meteorological observation and forecasting/warning capabilities of the PMD by upgrading and establishing new meteorological observation and data processing analysis systems, thereby contributing to the mitigation of damage caused by natural disasters.</p>
Contents of the Project	<p>Project Sites: Islamabad, Lahore, Multan, Karachi</p> <p>1) Facility Construction, Procurement of Equipment, etc.</p> <p>(1) Facility &lt;PMD Islamabad Head Office&gt; Meteorological radar tower (one building)</p> <p>(2) Equipment &lt;PMD Islamabad Head Office&gt; Weather forecasting and development system, meteorological data trunk communication system, Global Telecommunication System (herein after referred to as “GTS”) message switch system, meteorological radar data display system, wind profiler system &lt;PMD Islamabad Head Office (Islamabad Meteorological Radar Tower Facility)&gt; Meteorological radar system, meteorological radar data display system &lt;PMD Meteorological Office within the New Islamabad International Airport&gt; Meteorological radar data display system &lt;PMD Lahore Flood Forecasting Division&gt; Meteorological data trunk communication system</p>

<sup>1</sup> This map is developed based on the UN map. (Disclaimer: this map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the border line of any country or territory or its demarcation, or the geographic names.)

	<PMD Meteorological Office within Lahore International Airport> Meteorological data trunk communication system <PMD Karachi Tropical Cyclone Warning Center> Meteorological data trunk communication system <PMD Meteorological Office within Multan International Airport> Meteorological data trunk communication system, wind profiler system 2) Consulting Services/Soft Component Detailed design, construction supervision, soft component/training (meteorological radar observation, maintenance, etc.)			
Implementation Schedule	E/N Date	November 13, 2014		
	G/A Date	November 13, 2014	Completion Date	March 3, 2020 (timing of the hand over)
Project Cost	E/N Grant Limit/G/A Grant Limit: 2,615 million yen		Actual Grant Amount: 2,614 million yen	
Executing Agency	Pakistan Meteorological Department (PMD)			
Contracted Agencies	Main Contractors: Mitsubishi Corporation/Taisei Corporation (JV) Main Consultant: International Meteorological Consultant Inc./Japan Weather Association/CTI Engineering International Co., Ltd. (JV)			

## II. Result of the Evaluation

### [Summary]

This project aimed to mitigate devastations caused by natural disasters by improving the meteorological observation and forecasting/warning capabilities through upgrading and establishing new meteorological observation and data processing analysis systems in the capital Islamabad. At the time of planning, the Government of Pakistan formulated and approved the *National Disaster Management Plan* and the *Early Warning System Development Plan*, in which this project was given top priority. At the time of planning (2015), the SMRFC, which had just been established, was trying to improve the accuracy of short-range (within 24 hours) weather forecasts and the capacity of medium-range (over 48 hours) weather forecasts. However, there was no sufficient equipment for weather forecasting analyses and information communication. The meteorological radar system inside the PMD continued to malfunction because of aging, with the possibility that it would stop operating within a few years. Thus, updating the radar system was an urgent issue. In terms of “consistency with Japan’s ODA policy,” it was confirmed that this project is consistent with the development policy and needs stipulated in the *Country Assistance Policy for the Islamic Republic of Pakistan*. Regarding “internal coherence” (collaboration with JICA’s other projects/assistance), the “Project for Installation of Weather Surveillance Radar at Karachi” was implemented at around the same time, with the intention to ensure compatibility with the communication system of this project in order to allow transmission of meteorological observation data to the PMD Islamabad Head Office. As there were no delays or failures in the transmission of communication data between Karachi and Islamabad, there were cooperation and synergistic effects between the two projects. Regarding external coherence (collaboration with non-JICA organizations, coordination with international frameworks, etc.), no specific cooperation/coordination was anticipated between this project and non-JICA projects after the planning stage and thus high cooperation and synergistic effects are not observed. However, regarding the international framework, this project is consistent with Sustainable Development Goals (SDGs) such as SDG 13: “Take urgent action to combat climate change and its impacts” and therefore its relevance and coherence are high. With regard to efficiency, the outputs were implemented as planned. The project period significantly exceeded the initial plan because of a change in the construction method for the Islamabad Meteorological Radar Tower and a delay in the procurement of equipment for the wind profiler system to be installed at Multan International Airport. On the other hand, the project costs were mostly as planned. Therefore, the efficiency of the project is moderately low. Regarding the project effects, the actual values of the seven set indicators are in line with the target values in terms of quantitative effects. Regarding impacts, interviews confirmed that timely and accurate weather observations and forecasting/warnings became possible at the PMD, which have contributed to the mitigation of damage caused by meteorological disasters. Therefore, the effectiveness and impacts of the project are high. Concerning sustainability, due to the deteriorating financial situation of the Pakistani government, there are some concerns about securing spare parts and about the sustainability of future project effects. However, at the time of the ex-post evaluation, there are no problems with the related policy and system, the institutional/organizational aspects, the technical aspects, or the status of the operation and maintenance, which demonstrates sustainability. Therefore, the sustainability of the project effects is high.

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

<b>Overall Rating<sup>2</sup></b>	<b>A</b>	<b>Relevance &amp; Coherence</b>	③ <sup>3</sup>	<b>Effectiveness &amp; Impacts</b>	③	<b>Efficiency</b>	②	<b>Sustainability</b>	③
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### 1 Relevance/Coherence

[Relevance]

-Consistency with the Development Policy of Pakistan at the Time of Ex-Ante Evaluation

<sup>2</sup> A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

<sup>3</sup> ④: Very High, ③: High, ②: Moderately low, ①: Low

To improve the PMD's meteorological observation and forecasting/warning capabilities, the government of Pakistan formulated and approved the *National Disaster Management Plan* and the *Early Warning System Development Plan* at the National Disaster Management Committee in 2013. In these plans, this project was recognized as the highest priority. It provided assistance to improve meteorological observation and forecasting/warning capabilities, and to mitigate damage caused by natural disasters. Therefore, it was consistent with the policy of the government.

#### -Consistency with the Development Needs of Pakistan at the Time of Ex-Ante Evaluation

Prior to the start of the project, Pakistan would be hit by many natural disasters such as floods, landslides, cyclones and earthquakes, which caused enormous damage. To minimize damage, it was urgent to establish a disaster management system with advanced flood forecasting/warning based on regular meteorological observation and forecasting capabilities. The government established the SMRFC inside the PMD with the aim to improve the accuracy of short-range (within 24 hours) weather forecasts and the capability of medium-range (over 48 hours) weather forecasts. However, as it had just been established, the SMRFC did not have sufficient equipment or information communication equipment for weather forecasting analyses. In addition, the meteorological radar system at PMD continued to malfunction because of aging, with the possibility that it would stop operating within a few years. Thus, updating the radar system was an urgent issue. Therefore, this project was consistent with Pakistan's cooperation policy and its needs to improve meteorological observation and forecasting capacities.

#### -Appropriateness of Project Design/Approach

Since there were no major differences in the implementation of the outputs during planning or implementation and at the time of completion, the project plan, policy and approach were appropriate.

The ex-ante evaluation of this project indicated a lesson that "equipment should be properly maintained based on the maintenance plan and should be utilized as effectively as possible" for the implementation of the project. In this evaluation, the maintenance status was checked through the questionnaires, interviews with the PMD and on-site inspections. It was confirmed that there was a maintenance plan for the procured equipment and facilities and that they were being utilized in the appropriate manner.

#### [Coherence]

##### -Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation

In the *Country Assistance Policy for the Islamic Republic of Pakistan* formulated by Japan (April 2012), the basic policy (uppermost goal) of its assistance was "building a stable and sustainable society through economic growth." Along with the improvement of economic infrastructure, "ensuring human security and improvement of social infrastructure" was listed as one of the priority areas (intermediate goal), stating that Japan would contribute to "strengthening capabilities of disaster management to respond to frequent natural disasters." In addition, assisting disaster prevention measures was emphasized in the rolling plan attached to the policy.

This project aimed to improve the PMD's meteorological observation and forecasting and warning capabilities through the introduction of the weather forecasting and development system, etc., thereby contributing to the mitigation of damage caused by natural disasters. It is consistent with the *Country Assistance Policy for the Islamic Republic of Pakistan* and with development cooperation policy for Pakistan.

##### -Internal Coherence

At the time of planning, the JICA had implemented the "Project for Establishment of Meteorological Radar Network" (1989), "Project for Improvement of the Meteorological Radar Network (Phase 2)" (1997), "Technical Cooperation for Development Planning: Project for National Disaster Management Plan" (2010-2013), "Strategic Strengthening of Flood Warning and Management Capacity" (collaboration with United Nations Educational, Scientific and Cultural Organization (UNESCO)) (2011), with "Project for Installation of Weather Surveillance Radar at Karachi" (2015) in the pipeline. Of these, "Project for Installation of Weather Surveillance Radar at Karachi" was linked with the communication system of this project, as meteorological observation data were to be transmitted to the PMD Islamabad Head Office;<sup>4</sup> the implementation periods also overlapped. It can be inferred that there was tangible cooperation and results between the two projects (more specifically, expansion of the meteorological observation range of the PMD leading to improvement of meteorological observation and forecasting/warning capabilities). Therefore, there is internal coherence.

##### -External Coherence

At the time of planning, UNESCO and the Asian Development Bank (ADB) had supported Pakistan's disaster prevention sector through the "Strengthening Tsunami Early Warning System in Pakistan" (2008-2009) and the "National Flood Protection Plan III" (1998-2007), respectively. However, these projects aimed at strengthening tsunami early warning systems and flood prevention; strictly speaking, they differed from the direction of this project, which aimed to improve meteorological observation and flood forecasting/warning and management capabilities. In addition, the periods of implementation and completion were before this project began (1990s to 2000s), therefore it is difficult to say whether there was mutual cooperation or tangible synergistic effects.

On the other hand, in relation to international frameworks, this project contributes to the mitigation of damage caused by natural disasters through the improvement of meteorological observation and forecasting/warning capabilities. Therefore, it is consistent with SDG 13: "Take urgent action to combat climate change and its impacts."

#### [Evaluation Result]

In light of the above, the relevance and coherence of the project are high.<sup>5</sup>

<sup>4</sup> In this evaluation, we confirmed through interviews with the PMD that there were no delays or failures in the communication data transmission between Karachi and Islamabad.

<sup>5</sup> Relevance: ③, Coherence: ③

2 Effectiveness/Impacts<sup>6</sup>

[Effectiveness]

&lt;Quantitative Effects&gt;

Table 1 shows the quantitative effect indicators (baseline, target and actual values) of the project. At the time of planning, seven indicators and target values were set and improvement of meteorological observation and forecasting/warning capabilities was expected. For reference, Table 2 presents the main specifications and detection range of the new and old meteorological radar systems.

Table 1: Quantitative Effect Indicators of this Project (Baseline, Target and Actual Values)

Indicators	Baseline 2014 Baseline Data	Target 2020 3 Years after Completion	Actual 2022
a) Wind velocity observations up to 75 m/sec in Islamabad	No (manual velocity observation only)	Yes (200 km radius of the meteorological radar)	Yes (200 km radius of the meteorological radar)
b) Detectable maximum range of precipitation intensity 1 mm/h or more by the Islamabad meteorological radar (Unit: km radius)	350	450	450
c) Availability of data on hourly accumulated rainfall detected by the Islamabad meteorological radar	None	Yes	Yes
d) Spatial resolution and observation interval of precipitation data within the detection range of the Islamabad meteorological radar (Unit: average km mesh)	81.9	2.5	2.5
e) Gradation level of rainfall data under the Islamabad meteorological radar (Unit: gradation level)	6	256	256
f) Maximum altitude at which upper-air can be observed to monitor the wind direction and wind speed in Islamabad and Multan (Unit: km)	3	12	12
g) Weather forecast guidance (forecasts on quantitative precipitation, temperature, humidity and wind speed)	None	Yes	Yes

Source: JICA document (baseline, target values), answers to the questionnaire and interviews with the PMD (actual values)

(Reference) Table 2: Comparison of the Specifications and Detection Ranges of the New and Old Meteorological Radar Systems

Specification	Old Meteorological Radar System	New Meteorological Radar System
Frequency	5.3 GHz (C-Band)	2.7-2.9 GHz (S-Band) <sup>7</sup>
Wavelength	Approx. 5.7 cm	Approx. 10 cm
Detectable maximum range of precipitation intensity 1 mm/h or more	350 km	450 km radius
Detectable maximum range of wind velocity	—	200 km radius
Data grid (mesh)	5.0 km	0.625 km
Observable maximum wind	-	± 70 m/second or more
Transmission power	250 kW	10 kW (peak value)
Monitoring function for strong windstorms, etc.	None	Available
Function of rainfall accumulation	None	Available
Rainfall data	6 gradation level rainfall qualitative data	0-250 mm/h rainfall intensity quantitative data

Source: JICA document

As shown in Table 1, the actual values met the target values. Prior to the start of the project, the PMD planned to strengthen its capacity to transmit and distribute meteorological information. However, as the SMRFC had just been established, there was shortage of equipment for weather forecasting analyses and information communication. At the time of planning, the meteorological radar system continued to malfunction because of aging and was expected to stop operating within a few years. Through this project, meteorological observation and forecasting/warning capabilities have been improved by the introduction of the weather forecasting and development system, the GTS message switch system, the meteorological Doppler radar system, the meteorological data trunk communication system, the meteorological radar data display system, the wind profiler system, etc. For reference, Table 2 shows a comparison of the main specifications and detection ranges of the new and old meteorological radar systems. It illustrates the specifications used to achieve the actual values presented in Table 1.

<sup>6</sup> When providing the sub-rating, Effectiveness and Impacts are to be considered together.

<sup>7</sup> The C-band and S-band indicate microwave frequency bands. The C-band is used for communication satellites, fixed radio, wireless access, satellite telephony, etc., while the S-band is used for radar, satellite broadcasting, etc., in addition to the functions used in C-band. Frequency indicates the length or shortness of the wavelength.

## &lt;Qualitative Effect 1: Improving Weather Forecast Accuracy and Realizing Medium-term Forecasts Exceeding 48 Hours&gt;

In addition to short-range (within 24 hours) weather forecasts, the initially planned medium-range (over 48 hours) weather forecasts have become possible and weather forecast accuracy is improving as a result of this project. Table 3 shows the accuracy of the PMD's weather forecasts.

Table 3: Accuracy of PMD Weather Forecasts<sup>8</sup> (as of February 2023)

Within 24 hours	Within 48-72 hours	Within one week
90%	80%	60-70%

Source: PMD

The PMD weather forecasts are available from 24 hours to a week ahead. According to interviews with the PMD, because of the introduction of the meteorological radar system, the weather forecast accuracy is higher in the Islamabad and Karachi metropolitan areas but slightly lower in other rural areas. However, it has been confirmed that the accuracy is generally as per the values (average values) shown in Table 3.<sup>9</sup> The PMD articulated that the accuracy of weather forecasts has improved significantly since before the start of the project because of the introduced equipment.<sup>10</sup>

## &lt;Qualitative Effect 2: Improving the Accuracy of the Global Numerical Weather Prediction Model and Distributing Meteorological Observation Data to Meteorological Agencies in Each Country&gt;

Prior to the start of this project, the PMD planned to introduce a numerical weather prediction system in order to provide the public with more accurate medium-term weather forecasts through the establishment of the SMRFC. Introduction of a calculation system and peripherals necessary for highly accurate medium-term weather forecasts was planned so as to provide weather forecast guidance (e.g., precipitation, temperature, humidity and wind speed) by using the global numerical weather prediction model,<sup>11</sup> which is used in many developed countries. Through interviews with the PMD, it was confirmed that the accuracy of weather forecasts using the global numerical weather prediction model is increasing year-on-year.<sup>12</sup>

The project also introduced the information system of the World Meteorological Organization (WMO)<sup>13</sup> Information System (WIS). This system is used to transmit information and data of Surface Synoptic Observations (SYNOP)<sup>14</sup> to the GTS that uses international communication lines. Although the PMD had established a distribution network (link) between Islamabad and Tehran<sup>15</sup> by the time of the ex-post evaluation, meteorological observation information and data are not distributed to the meteorological agencies of other countries, including Japan. On the other hand, the PMD states that in the future, with the support of the WMO, the distribution network can expand as the meteorological observation system in Pakistan progresses.

## &lt;Qualitative Effect 3: Effects of Soft Component Training&gt;

Through the soft component training of this project, the PMD staff acquired computer skills and basic knowledge of the latest meteorological radar. In addition, it was confirmed that they had become able to: (1) maintain and inspect using measuring instruments, install (replace) spare parts in the machines and run operation checks, detect and address minor failures, run restoration checks and be prepared for serious failures; (2) record and manage the frequency of the utilization of overview of meteorological Doppler<sup>16</sup> radar system manuals and the radar system maintenance management ledger; (3) perform meteorological radar observations according to the observation sequence schedule based on the rainfall intensity and Doppler velocity observation data. The PMD staff commented, "The training was dialogical (two-way, interactive). The staff could acquire new skills and knowledge. After the training, they are making use of the skills and knowledge they have acquired through the training in their respective fields. I think it was a good opportunity." Therefore, it can be inferred that changes have occurred in both the work environment and in the awareness of staff regarding meteorological observation and maintenance of the procured equipment.

In summary, the introduction of the meteorological observation equipment by this project has improved the meteorological observation and forecasting/warning capabilities of the PMD, including short-range (within 24 hours) weather forecasts and realization of medium-range (over 48 hours) weather forecasts. Staff are working with the latest meteorological radar technology and knowledge. Therefore, both the quantitative and qualitative effects were achieved as per the planned expectations.

<sup>8</sup> Since values before the start of this project do not exist, comparative verification is difficult.

<sup>9</sup> Weather forecasting accuracy is relatively low especially in mountainous areas because of geographical factors.

<sup>10</sup> In the future, grant aid "Project for Installation of Weather Surveillance Radar in Multan City" and "Project for the Installation of Weather Surveillance Radar in Sukkur City" will advance the construction of weather radar towers in both cities, further strengthening the PMD's weather observation system. Therefore, it is thought that the forecasting accuracy over a wide area including the areas around the two cities will be further improved.

<sup>11</sup> The Global Spectral Model (GSM) uses numerical simulations to forecast changes in the state of the earth's atmosphere, oceans and land. By dividing the earth's atmosphere, oceans and land into fine grids, values are assigned to each grid based on weather elements such as temperature and wind, sea surface temperature, ground temperature, etc., and the time change of each value is calculated based on the laws of physics and chemistry to predict and forecast the near future conditions. The computer program used for the calculation is called a numerical prediction model.

<sup>12</sup> Apart from the GSM, the PMD also has a plan to introduce non-hydrostatic regional numerical weather prediction models (regional atmospheric models, such as the Weather Research and Forecasting Model). Among the physics equations used in numerical forecasting, it is one of the numerical forecasting models that does not use hydrostatic pressure approximation in the vertical motion equation. Thereby, weather forecasting can be made with higher resolution.

<sup>13</sup> The WMO is an international organization that conducts international standardization and coordination of meteorological projects, exchange of meteorological information and documents among member countries and regions.

<sup>14</sup> A numerical code used for meteorological observations from manned and unmanned stations, transmitted using a communication network (wired/wireless communication). Observations consist of numerical groups describing general weather information such as temperature, pressure and visibility at the station.

<sup>15</sup> According to the PMD, currently there are no problems with the accuracy of the weather forecasting data distributed to Iran. The establishment of a distribution network between Islamabad and Delhi (India) is also under consideration.

<sup>16</sup> The Doppler function can observe wind speed and rainfall movement direction up to 75 m/sec within a detection range radius of 200 km; it is possible to accurately monitor in real time the direction of movement of storms and rainfall, as well as storms accompanied by tornadoes that occur in an extremely short period of time and cause damage. It is also possible to identify heavy rainfall areas from wind convergence field data.

## [Impacts]

## &lt;Quantitative and Qualitative Effects: Contribution to Reducing Damage Caused by Meteorological Disasters (as a Result of Timely and Accurate Weather Observations and Forecasting/Warning)&gt;

Natural disasters, such as heavy rains, floods, landslides and cyclones, occur almost every year in Pakistan. The country faces floods, submergence of fields, collapse of houses, cutting of power lines, landslides, slope failures of roads, etc., leading to extensive human and economic damage. Most recently, in September 2022, record-breaking monsoon rains and melting glaciers in the northern mountains caused flooding affecting more than 3.3 million people. According to the NDMA, the total amount of loss and damage was more than US\$30 billion, while the reconstruction and restoration costs of social and livelihoods infrastructures are estimated to be US\$10-16 billion.

Under such circumstances, the PMD has established a system for meteorological observation using the meteorological radar system and satellites in addition to automatic and manual meteorological observation. It has become possible to utilize the latest forecast models that are to generate more accurate and rational weather products<sup>17</sup> by fully considering the characteristics of each region, such as geography and weather. Although it is difficult to predict natural disasters such as floods and landslides, the accuracy of predictions and early warnings of droughts, heatwaves, heavy rains and cyclones is improving. The PMD provided the following comments:

- “When heavy rain and flood damage occurred in September 2022, rainfall forecasts and warnings were issued more than 48 hours in advance. We were able to provide highly accurate weather products compared to before the start of this project.”
- “As another example, we could not accurately predict heatwaves before the start of this project. Now, it is possible to accurately predict and inform the public two to three days beforehand. Before the start of this project, about 200 people died in one day due to heatwaves. Now [although there are no specific statistics], we believe that we are saving lives.”
- “I think farmers are able to secure time [lead time] and take measures against heatwaves in order to protect their crops. This is an example of how highly accurate weather forecasts can be reported to the public at an early timing in an agricultural country, Pakistan. Therefore, the impact on socioeconomic aspects is thought to be significant.”
- “I believe that electric power companies are also able to obtain weather information at an early stage during heatwaves and manage power transmission and distribution thoroughly, thereby working to reduce human and economic losses.”<sup>18</sup>
- “At regular meetings among the ministries/agencies, the progress made in improving the accuracy of the PMD’s weather forecasts and strengthening the observation system has been well received by other ministries/agencies.”
- “At present, the Islamabad Meteorological Radar Tower of this project and the Karachi Meteorological Radar Tower of the follow-on project are the observation systems with the latest technology. Once the meteorological radar towers in Multan and Sukkur are completed, more accurate weather observations/warnings are expected over a wide area.”
- “Besides heavy rains, cyclones and heatwaves, the PMD also issues early warnings for heavy snowfall. When Murree city in Punjab was hit by heavy snow in January 2022, the PMD issued an early warning of heavy snow forecast, as a result of which many tourists postponed their visits. This is an example of how the early warning system can handle snowfall and that its accuracy is high.”

A meteorological radar data display system was introduced by this project at the new Islamabad International Airport (opened in 2018). The following comments were received from the airport staff:

- “In carrying out this project, there were restrictions and issues such as confidentiality and security in setting up communication infrastructure facilities at the new Islamabad International Airport and in operating meteorological observation data. Although it took time, communication between the airport and the PMD Islamabad Head Office is running smoothly and meteorological observation data are being distributed without delays at the time of the ex-post evaluation.”
- “Regarding the meteorological observation data distributed from the PMD, the airport requires data within a radius of 200 km from the Meteorological Radar Tower of the PMD Islamabad Head Office. In particular, importance is placed on meteorological radar products within a radius of 50 km from the Tower. As for wind, we provide air traffic controllers with highly accurate meteorological products. Unlike the old airport and other local airports, vertical wind data can be provided [with the meteorological radar data display system]. The accuracy of vertical wind data is high at the new airport, improving safety/reliability of flight departures and arrivals.”

In addition, the following comments were obtained from the NDMA<sup>19</sup> and the Ministry of Climate Change (MOCC):

- “The NDMA and the PMD disseminated information on the enhancement of the weather forecast system and the contribution of this project (strengthening the SMRFC system) through open seminars for the public. The improvement of weather forecasting capability is known not only among government agencies but also among the general public. While one can say that this project has improved the accuracy of short- and medium-term weather forecasts, considering today’s rapid climate change, technological innovation of equipment and software continues to be important, as it can generate more accurate weather forecast data. We think the level of disaster preparedness will be enhanced among people.” (comments from the NDMA executives)
- “Pakistan is among the top 10 countries most vulnerable to climate change. The government needs to take appropriate measures against climate change. Population growth and rapid urbanization are compounding the patterns of heatwaves, floods and cyclones each year. In such circumstances, improvement of the PMD’s meteorological observation and early warning capability is a necessary measure and can be a means of timely information provision. The meteorological observation system and infrastructure facilities owned by the PMD are of great value to the country and the role played by this project is significant.” (comments from the MOCC executives)

<sup>17</sup> A collection of numerical data such as atmospheric pressure, temperature, wind and humidity. It predicts weather conditions of the near future.

<sup>18</sup> It was also expressed that this may have contributed to the reduction in operating losses of electric power companies.

<sup>19</sup> The NDMA is responsible for establishing regional-level disaster management offices and formulating regional-level disaster prevention plans, while the PMD is responsible for meteorological observation and forecasting/warning of natural disasters.

Based on the above comments, this project is believed to have improved the PMD's meteorological observation and forecasting/warning capabilities, contributing to the mitigation of damage caused by meteorological disasters.<sup>20</sup>

## (2) Other Positive and Negative Impacts

### 1. Impacts on the Environment

This project was classified as Category C by the *JICA Guidelines for Environmental and Social Considerations* (April 2010), as it was judged to have minimal negative impact on the environment. It was confirmed through the questionnaires, interviews with the PMD and site visits that there were no particular negative environmental impacts (air pollution, water quality, noise/vibration, negative impact on the ecosystem, etc.) during the project and after its completion.<sup>21</sup>

### 2. Impacts on Social Environment (Resettlement and Land Acquisition)

The main components of this project were upgrading and establishing new meteorological observation and data processing analysis systems in the PMD Head Office and the meteorological radar tower; thus, there was no resident relocation or land acquisition. No compensation or other payments were made to local residents.

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

This project contributes to the mitigation of damage caused by natural disasters in Pakistan by improving the PMD's meteorological observation and forecasting/warning capabilities. Regarding gender equality, marginalized people, social systems and norms, human well-being and human rights, specific cases where this project had a direct impact could not be confirmed through the questionnaires and interviews. However, the PMD continues to update its meteorological observation and data processing analysis systems, including through this project, indicating that they plan to continue their work on more reliable meteorological observations and forecasting/warning. It is believed that the introduction of highly accurate meteorological observation and data processing analysis systems will increase the safety and security of the entire nation, promote disaster preparedness, contributing to the mitigation of human and property damage, in which this project is thought to play a part.

#### [Evaluation Result]

Regarding the quantitative effect indicators, the actual values of the seven indicators are aligned with the target values. Concerning impacts, the PMD has become able to conduct timely and accurate meteorological observations and forecasting/warning, which is believed to be contributing to the mitigation of damage caused by meteorological disasters. The expected outcomes and impacts of this project were achieved largely as planned. Therefore, the effectiveness and impacts of the project are high.

## 3 Efficiency

### <Outputs>

The outputs of this project are as described in "I. Project Outline: Contents of the Project" above. They were implemented as planned.

The meteorological radar tower was equipped with the latest equipment on the premises of the PMD Islamabad Head Office with the aim of realizing wider meteorological radar observations. The weather forecasting and development system is centered on the computers and peripheral equipment necessary to make highly accurate medium-term weather forecasting. The purpose of the meteorological data trunk communication system is to manage the meteorological data communication network and control data, etc. The GTS message switch system can distribute observation data to the world in a timely manner. The meteorological radar data display system enables continuous meteorological radar observations and improves the accuracy of forecasting and warning. The wind profiler system emits radio waves from the ground to the sky and monitors meteorological phenomena such as vertical distribution of wind direction and speed and turbulence up to about 4-12 km in the sky during precipitation.<sup>22</sup>

### <Inputs>

#### 1) Project Period

The project was planned to take place from January 2015 to September 2017 (33 months). The actual period was from January 2015 to March 2020 (63 months), which significantly exceeded the planned time (approximately 190% of the plan). The main reasons for the overrun are twofold. First, a) construction of the Islamabad Meteorological Radar Tower was delayed. The plan was to install the tower crane in a place where it would not interfere with exterior construction work when the outer wall was constructed and painted around the location where the supporting steel for the tower crane was installed. However, the outdoor stairs and eaves of the radar tower were changed to a precast concrete construction method. For safety considerations, it was necessary to install a tower crane in a place that overlapped with the exterior work, which took longer than expected from the adjustment to the construction, leading to a delay of approximately three months. Second, b) during the procurement of equipment related to the wind profiler system to be installed at Multan International Airport (at the time of the inspection by Karachi Customs), the antenna part suffered a serious break arising from an unexpected accident and it was decided to have the antenna remanufactured at a manufacturing plant in Japan. Procedures related to

<sup>20</sup> (Reference information) The PMD is also focusing on strengthening its ability to disseminate information to the public. By opening a website to provide easy-to-understand and easy-to-read weather-related information for viewers (citizens), they are focusing on disseminating information through video viewing services. Through the YouTube site (PMD Weather TV), they are working to provide information that is easy to understand. They have also developed a smartphone application (only for Android) to increase opportunities for citizens to obtain weather-related information.

<sup>21</sup> The PMD has a dedicated Planning Department in charge of environmental matters. However, since there have been no particular negative impacts after completion, they have not measured environmental monitoring data such as air pollution, water quality, noise, vibration or impacts on the ecosystem. If a negative environmental impact is confirmed, the PMD will contact the Pakistan Environmental Protection Agency (EPA) and the agency will respond accordingly.

<sup>22</sup> Continuous time observation is possible, and automatic observation is possible with almost no human intervention.

procurement and delivery were significantly delayed, approximately 24 months behind schedule.

## 2) Project Cost

Initially, the Japanese side's project cost was planned to be 2,615 million yen, while the actual amount was approximately 2,614 million yen (approximately 100% of the plan). Therefore, the costs were largely as planned.

## [Evaluation Result]

Although the project cost was within the plan, the project period significantly exceeded the plan. Therefore, the efficiency of the project is moderately low.

## 4 Sustainability

### -Policy and System

The *National Disaster Management Plan* and the *Early Warning System Development Plan* announced by the government of Pakistan in 2013 aimed to mitigate damage caused by natural disasters and strengthen the disaster prevention system by improving the PMD's meteorological observations and forecasting/warning capabilities. This project aimed to improve meteorological observation and forecasting/warning capabilities and to reduce disaster risks through assistance in the field of disaster prevention in Pakistan, therefore sustainability in terms of policies and systems is high.

### -Institutional/Organizational Aspect

The executing agency is the PMD (headquartered in Islamabad). Established in 1947, the PMD is the only governmental agency providing meteorological services in Pakistan. At the time of the ex-post evaluation, the total number of employees was over 2,000. Under the Director General, there are the SMRFC, the Central Water Resources Monitoring and Early Warning Center, the Central Earthquake Monitoring/Tsunami Warning Center, the Administration Office, the Flood Forecasting Office and the Research and Development Office. Departments are subdivided according to regions and forecasting items. There are departments such as the National Weather Forecasting Center (NWFC) and the Tropical Cyclone Warning Centers (TCWCs) that carry out weather forecasting work. The PMD places the NWFC at its core; it conducts meteorological work by dividing the country into four meteorological districts (Karachi, Lahore, Quetta and Peshawar).

The PMD Islamabad Head Office (28 department staff members<sup>23</sup>) is responsible for the operation and maintenance of the main meteorological observation equipment and meteorological radar tower of this project. In addition, three people at New Benazir Bhutto International Airport Meteorological Office, 28 people at the PMD Lahore Regional Meteorological Center, 22 people at the PMD Lahore Flood Forecasting Division, two people at the PMD Karachi Cyclone Warning Center and nine people at the PMD Multan Meteorological Office are working as operation and maintenance staff. Their main duties include weather forecasting, data transfer/receiving/recording/monitoring, software operation, server management, management of communication equipment and management/operation of high-performance terminal equipment (workstations). In this evaluation, it was confirmed through site visits and interviews that the necessary number of staff was allocated for operation and maintenance work. Daily, weekly, monthly and yearly inspections and maintenance of equipment and facilities, including meteorological radars, are carried out. System inspections (operational checks) are also conducted on a regular basis.

There are therefore no major problems with the organization and system of operation and maintenance.

### -Technical Aspect

Through the questionnaires, interviews and site visits, it was confirmed that the operation and maintenance staff of the PMD Islamabad Head Office, New Benazir Bhutto International Airport Meteorological Office, the PMD Lahore Regional Meteorological Center, the PMD Lahore Flood Forecasting Division, the PMD Karachi Cyclone Warning Center, and the PMD Multan Meteorological Office have extensive work experience. Technical staff have completed graduate school, graduated from a four-year university, or have a diploma in majors such as electrical engineering.

The PMD also holds regular training sessions for its staff, whether they are at the Head Office or based locally. The Institute of Meteorology and Geosciences (IMG) in Karachi provides training on weather forecasting and observation techniques. On-the-Job Training (OJT) is also conducted.

On the other hand, the PMD Karachi and Lahore branch offices made several comments stating that "continuation of training for appropriate maintenance and training on operation of visual weather software" was necessary. At present, the local branch offices have not made any requests directly to the Head Office and there have been no major problems with operation and maintenance. Although it does not appear that such training should be introduced immediately or require an urgent solution, it is necessary to have a system that constantly considers the introduction of training that meets the needs of the field in order to carry out meteorological observations and forecasting/warning with confidence.

In addition, operation and maintenance manuals for meteorological radar equipment are stored in each facility. Staff in charge refer to and utilize the manuals as necessary.

In summary, there are no major problems with the technical level of the operation and maintenance of this project.

### -Financial Aspect

Table 4 shows the operation and maintenance budget for meteorological observation equipment and meteorological radar tower facilities (equipment and facilities of the PMD Islamabad Head Office).

<sup>23</sup> This includes personnel working at the meteorological radar tower.



Table 4: Operation and Maintenance Budget of the PMD

Item	(Unit: Rs.)		
	2020	2021	2022
Operation Budget	15.7 million	15.7 million	15.7 million
Maintenance Budget	1.65 million	1.65 million	1.65 million

Source: PMD

Remark: 1 Rs. = 0.496 JPY (JICA rate as of February 2023)

With regard to Table 4, the following comments were received from the PMD employees: “While it is by no means a sufficient level, necessary amount has been allocated;” “The fiscal year began in July and half a year has passed since then. As of the end of February 2023, the diesel fuel for the generator has already been used up at the Meteorological Radar Tower at Islamabad Head Office. As there is no budget left for new purchases, there are concerns about operating generators in emergencies such as power shortages. We have to wait until the next fiscal year, but the central government has issued a notice that they will not allocate any new budget for purchasing diesel fuel;” “Backup batteries for the small uninterruptible power supply (UPS) installed at the Meteorological Radar Tower are unlikely to be available in the future. The central government regards backup batteries as expensive goods and has issued directives to refrain from purchasing them. At the time of the ex-post evaluation, there are no major problems due to lack of budget. Nevertheless, we are worried for the future when they break down or need to be replaced;” and “As spare parts for about five years were procured in this project, there is no shortage at the time of the ex-post evaluation. It helps us greatly. Although two-years-worth of spare parts is still at hand, considering the situation above, we are worried whether we will be able to raise funds and whether there will be any problem with the purchasing procedure when the time comes.” Such comments came at the time of a financial crisis of the central government. In addition to the chronic shortage of foreign exchange reserves, the government has been prioritizing budget allocation for reconstruction as it faced a disaster (flood damage) in September 2022. According to the PMD executive, “All public institutions in the country are facing budget shortfalls.” At the time of the ex-post evaluation, while it is not possible to say whether the PMD will be able to secure a budget in the future, weather forecasting and early warnings for the general public are important issues linked to disaster prevention and damage mitigation, and it is hard to imagine that no countermeasures will be taken. Thus, it is presumed that the budget allocation is not a low priority for the government.

In summary, it seems that there are slight concerns about future sustainability and financial aspects. Nevertheless, there is no lack of maintenance due to shortage of budget for the procured equipment and for the Islamabad Meteorological Radar Tower, etc.; thus, it cannot be concluded that there is a problem with the continuity of the effects.

#### -Environmental and Social Aspect

No negative environmental or social impacts have been confirmed. No specific mitigation measures have been taken.

#### -Preventative Measures to Risks

During implementation, the Pakistani side’s responsibility for the project outputs, including the supply of utility facilities, was properly effected. No major security problems or political instability occurred during the project period; any particular risks, external conditions or factors to be controlled were not observed.

#### -Current Status of Operation and Maintenance

As mentioned in the “Financial Aspect” section, a certain number of spare parts are secured. However, if there is no improvement in the financial situation of central government, it is possible that there will be problem with the spare parts procurement system in the future.

Staff at the Meteorological Radar Tower in Islamabad and regional facilities work 24 hours a day (in three shifts). The shift system was functioning at all facilities; no problem was observed with the staffing/working system.

It was confirmed that the operation and maintenance status of all equipment is good at the PMD Islamabad Head Office, the PMD Meteorological Office inside the New Islamabad International Airport, the PMD Lahore Flood Forecasting Division, the PMD Meteorological Office inside Lahore International Airport, the PMD Karachi Tropical Cyclone Warning Center and the PMD Meteorological Office inside Multan International Airport. As mentioned in the “Institutional/Organizational Aspect” section above, each facility of the PMD is responsible for weather forecasting, data transfer/receiving/recording/monitoring, software operation, server management, management of communication equipment and management/operation of high-performance terminal equipment (workstations). The equipment and facilities are cleaned and inspected as needed. In this evaluation, it was confirmed through the questionnaires, interviews with staff working at the PMD Islamabad Head Office and regional facilities and site visits that the procured equipment and meteorological radar towers are generally well maintained.

In summary, there are no major problems with the current status of operation and maintenance of this project.

#### [Evaluation Result]

Therefore, the sustainability of the project effects is high.

### III. Recommendations & Lessons Learned

#### -Recommendations to Executing Agency

None

#### -Recommendations to JICA

None

**-Lessons Learned**

(Importance of checking the construction site, selecting the construction method and ensuring thorough communication between project stakeholders before the start of the project or at an early stage after the project begins so that the construction method and design do not change. Importance of focusing on preventing construction delays in the case of construction method changes.)

During the construction of the Islamabad Meteorological Radar Tower, it was discovered that exterior wall construction and painting around the tower crane support steel installation location could only be done after the tower crane was dismantled. All construction work, including the exterior work, was delayed. In the initial plan, the tower crane was intended to be installed in a place that would not interfere with external construction work. However, after the design stage, the exterior stairs and eaves of the radar tower were changed to precast concrete construction method which made it necessary to install a tower crane in a place overlapping with the exterior construction work, and it took time from the adjustment to the construction. When forming similar projects in the future, it is desirable to check the construction site, select the construction method and thoroughly communicate with the project stakeholders before the project begins or at an early stage of implementation, so that as far as possible, there will be no change to the construction methods and design. In case the construction method is changed, it is desirable to focus on preventing delays in the construction period.

**IV. Non-Score Criteria**

**-Performance**

[Objective Perspective]

As part of consulting services, soft component training was implemented for the PMD's technical staff on themes such as meteorological radar adjustment/failure investigation, meteorological radar operation/management, meteorological radar observation and weather forecasting guidance. As the PMD was not familiar with the introduction of the latest meteorological observation system, this training was essential for the smooth operation and maintenance of the system. It contributed to the enhancement of the PMD's operational capability and is a response aimed at adapting to the project environment. Therefore, it can be said that necessary support was provided to the executing agency.

**-Additionality**

None



Picture 1: Wind Profiler System (partial)  
(Inside the PMD Islamabad Meteorological Radar Tower)  
(Source: picture taken by the evaluator)



Picture 2: Meteorological Radar Data Display System  
(PMD Meteorological Office Inside the New Islamabad International Airport)  
(Source: picture taken by the evaluator)



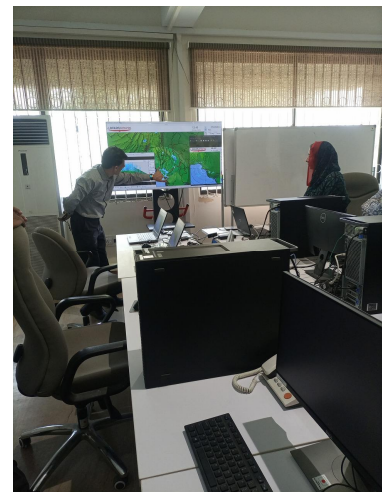
Picture 3: Meteorological Data Trunk Communication System  
(partial)  
(PMD Lahore Flood Forecasting Division)  
(Source: picture taken by the local survey assistant)



Picture 4: Wind Profiler System (partial)  
(PMD Meteorological Office Inside Multan International Airport)  
(Source: picture taken by the local survey assistant)



Picture 5: Meteorological Data Trunk Communication System (partial)  
(PMD Lahore Flood Forecasting Division)  
(Source: picture taken by the local survey assistant)



Picture 6: Inside Karachi Tropical Cyclone Warning Center  
(Source: picture taken by the local survey assistant)