Republic of the Philippines

FY2020 Ex-Post Evaluation of Grant Aid Project

"The Project for Improvement of Equipment for Disaster Risk Management"

External Evaluator: Mitsue Mishima, OPMAC Corporation

## 0. Summary

This project aimed to improve the monitoring capacity for earthquakes and tsunamis and drainage measures by installing monitoring equipment for earthquakes and tsunamis and mobile drainage pumps throughout the Republic of the Philippines (hereinafter referred to as "the Philippines"), therefore reducing the human and economic damage caused by such disasters. The implementation of this project was well in line with the development plan and development needs of the Philippines and with Japan's ODA policy, and is highly relevant. The efficiency is fair because both the project cost and the project period exceeded the plan. Of the equipment maintained through this project, problems with the Philippine Institute of Volcanology and Seismology (PHIVOLCS) data transmission of the earthquake intensity meter and tsunami wave detector had not been resolved at the time of the ex-post evaluation. As for other equipment, due to the spread of the new coronavirus infection (COVID-19), travel restrictions in various locations made it difficult to replace batteries and parts and to deal with equipment malfunctions, and therefore some of the equipment seems not to be operating. However, the equipment has contributed to speedy observations and improved information on earthquakes and tsunamis in the past. As for the mobile drainage pumps of the Department of Public Works and Highways (DPWH), they have helped prevent flood damage or recovery after flood disasters through drainage, contributing to a reduction in human and economic damage. For these reasons, the effectiveness and impact are considered fair as a certain effect of the implementation of the project has been observed. Although sustainability was observed to a certain degree in terms of the institutional/organizational, technical, and financial aspects of the operation and maintenance system, at the time of the ex-post evaluation, there were some problems with equipment operation due to defects or failures. Therefore, the sustainability of the project effects is fair.

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

## 1. Project Description


Project Site

Equipment maintained by this project
(PHIVOLCS headquarters monitors, IPSTAR satellite communication equipment)

### 1.1 Background

The Philippines is one of the countries with the highest number of natural disasters in Southeast Asia. The economic and human damage caused by these disasters that occur almost every year is extensive, and the repeated damage to the social infrastructure has had a long-term impact on economic activities. The countries seriously affected by the Sumatra Earthquake and the Asian Tsunami in 2004 are improving their disaster prevention capabilities, measuring earthquakes, and disseminating earthquake information. However, monitoring networks, accurate data analysis systems, and warning systems for earthquakes and tsunamis are still under development in those countries.

Meanwhile, the Great East Japan Earthquake that occurred on March 11, 2011, resulted in tremendous damage to Japan and reminded the international community of the importance of disaster prevention. It is still a fresh memory that drainage in the tsunami-damaged area was a significant issue in the process of socio-economic recovery after the Great East Japan Earthquake, and at that time, the usefulness of mobile drainage pumps was reacknowledged.

In the Philippines, PHIVOLCS, a science and technological service institute of the Department of Science and Technology (DOST), develops and operates prediction technology for volcanic eruptions, earthquakes, tsunamis, and other related phenomena and is building a monitoring network. PHIVOLCS has been required to update seismic measurement equipment, enhance the monitoring network, and improve monitoring capabilities. In addition, for all disasters, including earthquakes, tsunamis, and floods, DPWH is responsible for "developing a disaster-resistant infrastructure" as a disaster prevention measure and "recovering and reconstructing infrastructure" after disasters. The deployment of mobile drainage pumps was decided upon to satisfy this need.

### 1.2 Project Outline

This project aimed to improve monitoring and drainage capacity for earthquakes and tsunamis by installing monitoring equipment and mobile drainage pumps throughout the Philippines, thus contributing to a reduction in the human and economic damage due to disasters such as earthquakes and tsunamis.

| | | |
|---|---|---|
| Grant Limit/Actual Grant Amount | | 1 billion yen / 1 billion yen |
| Exchange of Notes Date/Grant Agreement Date | | March 2012 /June 2012 |
| Executing Agencies | | Philippine Institute of Volcanology and Seismology (PHIVOLCS)<br>Department of Public Works and Highways (DPWH) |
| Project Completion | | July 2014 |
| Target Area | | The Philippines |
| Contractors | Main Consultants | Oriental Consultants Co., Ltd.*<br>Pacific Consultants Co., Ltd. |
| | Procurement Agent | Japan International Cooperation System (JICS) |
| | Equipment Procurement | Toyota Tsusho Corporation, NEC Corporation |
| Basic Design/Preparatory Survey | | April 2012-March 2013 |
| Related Projects | | <JICA Technical Cooperation><br>Science and Technology Research Partnership for Sustainable Development (SATREPS) "Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information in the Philippines" (2010-2015)<br><Other Donors><br>United Nations Development Programme (UNDP), Agency for International Development (AusAID) "READY Project" (2006-2013） |

*At the time of ex-post evaluation, Oriental Consultants Global Co., Ltd.

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Mitsue Mishima, OPMAC Corporation

### 2.2 Duration of Evaluation Study

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

Duration of the Study: December 2020 – January 2022

Field Study: A field survey by an external evaluator was not conducted because of travel restrictions due to the rapid spread of COVID-19 in the Philippines.

### 2.3 Constraints during the Evaluation Study

As it was impossible for the external evaluator to conduct a field survey in the Philippines due to the rapid spread of COVID-19, executing agencies were interviewed online, and field survey assistants visited the project site. After analyzing the results of these activities and the materials related to the project submitted by the executing agencies, the external evaluator conducted a desk evaluation.

## 3. Results of the Evaluation (Overall Rating: C[1])

### 3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of the Philippines

This project was highly consistent with the development policy of the Philippines from the time of the ex-ante evaluation to the ex-post evaluation. Due to its geographical location and its characteristics as an island country, the Philippines is susceptible to typhoons and earthquakes. Thus, disaster prevention and preparedness has been prioritized in the development policy.

In The *Philippine Development Plan (2011-2016)* at the time of this project's ex-ante evaluation, a major policy to strengthen disaster risk reduction at both national and local levels was set. In the field of disaster risk management, *The National Disaster Risk Reduction and Management Framework (NDRRMF)*" and *The National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028* were established in June 2011 and February 2012, respectively, based on the *Disaster Risk Reduction and Management Law (Republic Act No. 10121)* enacted in 2010 to reduce disaster risk. NDRRMP covers four thematic areas, namely "Disaster Prevention & Mitigation," "Disaster Preparedness," "Disaster Response," and "Disaster Rehabilitation and Recovery." The long-term goals, sector-wise outputs, action plans, etc. in each priority area are also included. This project addresses "Disaster Prevention & Mitigation," which is one of the priority areas of NDRRMP as a national high-level plan, to contribute to the promotion of the achievement targets "Enhance Monitoring, Forecasting and Hazard Warning," "Develop Disaster-Resistant Infrastructure," and "Recover and Reconstruct Infrastructure."

In the *Philippine Development Plan (2017-2022)*, at the time of the ex-post evaluation, the implementation of disaster vulnerability and risk assessments throughout the Philippines was to be carried out in one of the three pillar policies, "Reform to reduce inequality." Regarding flood control, the plan stated that flood control and dredging master plans would be updated, and that coordination with related agencies and management capabilities would be strengthened.

Regarding earthquake monitoring, PHIVOLCS has been continuously working to strengthen the network of earthquake intensity meters under the "Development and Management of

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[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[2] ③: High, ②: Fair, ①: Low

Philippine Earthquake Intensity Meter Network" project of the *National Earthquake Monitoring and Information Program*, and to improve the management of seismic stations under The *Management of Operations of Seismic Stations Project*. Regarding tsunami monitoring, PHIVOLCS has been promoting the development of tsunami monitoring and warning systems under the *National Tsunami Monitoring and Early Warning System Program 2021*.

### 3.1.2 Consistency with the Development Needs of the Philippines

This project was consistent with the development needs from the time of the ex-ante evaluation to the ex-post evaluation. In the Philippines, where there are many disasters such as earthquakes and tsunamis, there is a high need to improve the monitoring equipment for those disasters in order that the situation may be grasped accurately and that water can be drained after tsunamis and floods.

In the Philippines, which has many fault lines and about 300 volcanoes, and is one of the most earthquake-prone countries in the world, more than 60 seismic stations have been established. However, some earthquake monitoring equipment requires renewal, and the development of a telemetry network of strong motion seismographs has been delayed in comparison to other Asian countries. This has made it difficult to grasp the magnitude of seismic motion at epicenters and to issue early tsunami warnings. Furthermore, nationwide monitoring networks and simulation databases were not developed for tsunamis, and accurate and prompt warnings were not being issued, so the strengthening of the monitoring capabilities for earthquakes and tsunamis was necessary.

In addition, the Philippines has a high risk of tsunamis due to its geographical position, and flood damage caused by typhoons occurs frequently every year. Some of the country's drainage pump station facilities constructed in the past have deteriorated, and there are areas where the existing drainage pump stations cannot manage floods. Thus, it has been necessary to strengthen drainage measures.

### 3.1.3 Consistency with Japan's ODA Policy

The Country Assistance Policy for the Republic of the Philippines (April 2012) stated that support for infrastructure development to respond to disasters, including soft aspects, would be provided as a support measure for "Disaster Risk Reduction and Management" under the priority theme of "Overcoming Vulnerability and Stabilizing Bases for Human Life and Production Activity." In addition, the JICA Country Analysis Paper (March 2012) positioned the disaster prevention sector under "Overcoming Vulnerability" to improve hard and soft infrastructure and provide support for maintenance, with the organizational structure based on the capacity of the Local Government Unit (LGU) in the target area. Therefore, this project, which aimed to improve earthquake and tsunami monitoring capabilities and drainage capacity, aligns with these policies.

Based on the above, this project has been highly relevant to the Philippines's development plan and development needs and as well as Japan's ODA policy. Therefore, its relevance is high.

### 3.2 Efficiency (Rating: ②)

#### 3.2.1 Project Outputs

As shown in the table below, the sets of real-time earthquake and tsunami monitoring systems for PHIVOLCS and the eight DPWH mobile drainage pumps were prepared in the quantities as initially planned (refer to Attached Map 1 -3). Each piece of equipment was installed in various places by the Philippine side. However, the earthquake intensity meter could not be installed at the time of planned installation due to a transmission problem, and had not been installed at the time of the ex-post evaluation (further details are given in “3.3.1 Effectiveness”, “3.3.1.1 Quantitative Effects (Operation and Effect Indicators), (1) Operational Status” below).

Table 1: Planned and Actual Project Outputs

| Equipment | Quantity (Planned/actual were same) (At time of completion: 2015) |
|---|---|
| **● Real-time Earthquake Monitoring System** | |
| Broadband Strong Motion Seismometer (Real-time) | 10 stations |
| Strong Motion Seismometer (Real-time) | 36 stations |
| Earthquake Intensity Meter (Real-time) | 240 sets |
| Earthquake Monitoring Software | 2 sets |
| Earthquake Monitoring System | 1 set |
| Headquarters Satellite Communication Equipment | 1 set |
| **● Real-time Tsunami Monitoring System** | |
| Tsunami Wave Detector | 19 stations |
| Tsunami Data Transmission Station | 19 stations |
| Tsunami Monitoring System | 1 set |
| Tsunami Simulation Database Development Hardware | 1 set |
| **● Mobile Drainage Pumps** | |
| Mobile Drainage Pumps | 8 units |

Source: "FY2011 Preparatory Survey Report on The Project for Improvement of Equipment for Disaster Risk Management in the Republic of the Philippines" (February 2017) pp. 3-4 for the quantity. Regarding the installation status, questionnaire answers from PHIVOLCS (May 2021).

It was confirmed with PHIVOLCS at the time of the ex-post evaluation that the set of real-time earthquake monitoring systems and real-time tsunami monitoring systems had been installed at the locations generally as planned. After confirmation with DPWH, the actual placement of the mobile drainage pumps was partially changed from the planned locations. Considering the flood damage in Manila city at the time of project implementation and that the area is an economic priority zone, the location of two mobile drainage pumps for Region V (Bicol), Legazpi City, Albay State and Region VI (Wester Visaya), Iloilo City, Iloilo were changed. To increase placement in Metro Manila, these were relocated to Los Baños, Laguna, in Region IV-A Calabarzon, an economic zone near Manila. This placement change was to respond to economies where there is a greater need for faster recovery.

Photo 1: Strong Motion Seismometer (Region VIII Leyte, Palo earthquake monitoring station)

Photo 2: Tsunami Wave Detector (Region X Mindanao, Mati)

Photo 3: Mobile Drainage Pump (Region III Pampanga, San Fernando)

### 3.2.2 Project Inputs

#### 3.2.2.1 Project Cost

As shown in the table below, the project cost was higher than planned due to the increased costs borne by the recipient side, and the total project cost exceeded the plan (100.6% of the plan). The cost of the installation of the earthquake intensity meter will be further incurred in the future. However, the sub-rating will be evaluated as fair even after it is added, as the total will not reach 150% of the planned total project cost.

Table 2: Planned and Actual Project Costs

| Item | Plan (May 2012) | Actual[2] (August 2021) |
|---|---|---|
| Total Project Cost | 1.005 billion yen | 1.011 billion yen |
| Grant Aid | 1 billion yen | 1 billion yen |
| Recipient side[1] | 5.71 million yen<br>(2.87 million Philippine Peso) | 11.38 million yen<br>(4.97 million Philippine Peso[3]) |

Source: JICA documents, Questionnaire answers from executing agencies
Note 1: Exchange rates: 1PHP=1.99 yen (May 2012) for Plan, 1PHP=2.29 yen (Average between 2012-2017) for Actual
Note 2: Earthquake intensity meters have not been installed in various areas, and therefore the actual installation costs to be borne by the recipient side are not included.
Note 3: Sum of 4,834,337 Philippine Peso (PHIVOLCS) + 137,000 Philippine Peso (DPWH)

3.2.2.2 Project Period

The project period is from the conclusion of the E/N to the delivery of all equipment. The plan was from March 2012 to February 2015 (36 months), but the actual project period was from March 2012 to October 2015 (44 months), exceeding the plan by 8 months (122% of the plan). Therefore, the evaluation of the sub-rating is fair.

Looking at each planned and actual project period in Table 3, it can be seen that the main delays in the project period were due to PHIVOLCS equipment. According to PHIVOLCS, the port of Tacloban on Leyte Island, where equipment was to be installed, was damaged by the large-scale Yolanda typhoon in November 2013. As it was decided that there would be recovery and further expansion of the area, the equipment installation site needed to be changed from the initial location. According to the PHIVOLCS report, the Port Authority claimed that the equipment installation location as planned would affect port operation, and therefore a new site needed to be re-examined and negotiated, which was also a factor in the delay.

Table 3: Planned and Actual Project Period

| Item | Plan | Actual | Difference |
|---|---|---|---|
| E/N Sign to End of Preparatory Survey | March 2012-March 2013<br>(13 months) | March 2012-March 2013<br>(13 months) | — |
| (PHIVOLCS)<br>Bidding/Procurement to delivery of real-time earthquake and tsunami monitoring system | September 2013-February 2015<br>(18 months) | September 2013-October 2015<br>(26 months) | +8 months |
| (DPWH)<br>Bidding/Procurement to delivery of mobile drainage pumps | June 2013-June 2014<br>(13 months) | June 2013-July 2014<br>(14 months) | +1 month |

Source: JICA Documents, Questionnaire answers from executing agencies
Note: The definition of project completion is the time of delivery of the equipment according to plan

From the above, it can be seen that both project cost and project period exceeded the plan. Therefore, the efficiency of the project is fair.

### 3.3 Effectiveness and Impact[3] (Rating: ②)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

(1) Operational Status

[Real-time Earthquake and Tsunami Monitoring System Sets]

Table 4 shows the operational status of each piece of equipment at the time of the ex-post evaluation (as of August 2021). In addition to the earthquake intensity meters that had not been installed at the time of the ex-post evaluation, some of the equipment was out of operation.

[3] Sub-rating for Effectiveness is to be put with Consideration of Impacts.

Prior to this project, Japanese technical cooperation had been implemented so that PHIVOLCS could promptly convey highly reliable information to disaster prevention-related organizations through observing and analyzing earthquakes, tsunamis, and volcanoes with the support of the Science and Technology Research Partnership for Sustainable Development (SATREPS) “Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information” (2010-2015). As for the earthquake intensity meters, this project used the same equipment as procured in the SATREPS project and their operation was verified at test installations at two monitoring stations in the Philippines before shipment. However, when the equipment was installed in various places after delivery, it was found that it could not transmit data from most locations, and PHIVOLCS returned the installed equipment to headquarters. The response to the data transmission problem has been delayed, and at the time of the ex-post evaluation, it was still to be installed. Delivery of the project equipment to the recipient government has been completed, and although it was planned that most of the equipment installation and confirmation of the operating system was to be handled by the government who were to assure installation and the system operation being in place, operational support post installation has also been necessary.

A problem with the data transmission of the earthquake intensity meter was also found in the SATREPS project, however, this was resolved after adjustments were made to the data transfer speed. The Philippine side requested that JICA conduct a follow-up cooperation survey in 2017 to look into the problem with the earthquake intensity meter. At the time of this ex-post evaluation (FY2021), it was planned that the follow-up project would take the same measures as the SATREPS project to adjust the earthquake intensity meter.

Table 4: Operational Status of Equipment

| **Equipment** | **Number of installed pieces of equipment (Completed in 2015)** | **Number of pieces of equipment in operation (August 2021)** | **Operational Status (August 2021)** |
|---|---|---|---|
| Broadband Strong Motion Seismometers (Real-time) | 10 | 3 sets in operation | ➢ 6 sets need replacement of batteries or spare parts, or onsite inspection and repairs, but operation has been suspended because of difficulties in sending staff under travel restrictions due to the spread of COVID-19.<br>➢ 1 set is out of order and will be repaired in Japan without the need for outside funds. |
| Strong Motion Seismometers (Real-time) | 36 | 34 sets in operation | ➢ 2 sets are out of operation. The Intensity Meter Module is out of order in one set, and a solution is being confirmed with the manufacturer. The building housing one set was damaged by a typhoon and the Intensity Meter Display Monitor broke at the end of last year. The response has been delayed with staff unable to access the site under travel restrictions due to the spread of COVID-19. |

| Equipment | Number of installed pieces of equipment (Completed in 2015) | Number of pieces of equipment in operation (August 2021) | Operational Status (August 2021) |
| --- | --- | --- | --- |
| Earthquake Intensity Meters (Real-time) | Uninstalled | — | ➢ 200 locations were planned for installation, but installation has not yet taken place due to data transmission issues (40 units were spare units) |
| Tsunami Wave Detectors and Data Transmission Stations (Real-time) | 19 | 6 locations in operation<br>6 locations recording data | ➢ Only 6 locations can record and transfer data. Data cannot be transferred to the headquarters at 6 locations, but the tsunami wave detector is in operation and data is being recorded.<br>➢ The remaining 7 detectors are not operating nor is data being recorded due to problems with equipment and batteries, such as damage caused by a ship collision and the need for replacement parts. Response has been delayed with staff unable to access the site due to the spread of COVID-19. |
| Mobile Drainage Pumps (Owned by DPWH) | 8 | 6 units in operation<br>2 units under repair | ➢ The 2 units under repair were in Davao and Laguna.<br>➢ Of 6 mobile drainage pumps in operation, one is a broken submerge pump out of two pumps. |

Source: JICA Documents, Questionnaire answers from executing agencies

According to project members, the time required for the implementation of the follow-up cooperation requested in 2017 was due to the significant time needed by JICA to communicate with equipment manufacturers and project members regarding countermeasures for the earthquake intensity meter problems. The follow-up cooperation scheduled for FY2020 was delayed by another year due to the spread of COVID-19.

When confirmation of the operational status of the earthquake and tsunami monitoring equipment (excluding the earthquake intensity meter) was made, it was found that some of the equipment that had been running at the start of operation was out of service as of August 2021. Reasons for this included unreplaced batteries, defective parts in need of replacement, and data transmission issues. At the time of the ex-post evaluation, the equipment operation rate was low, so it is assumed that data collection and analysis within the scope that was initially intended is currently limited. However, for broadband strong-motion seismometers, tsunami wave detectors, and data transmission stations, if staff can go onsite to replace batteries and parts, or if the data transmission issues can be resolved, those components can restart operation. As of August 2021, it was unclear when COVID-19 restrictions would be lifted and when staff would be able to go onsite. It was planned that the ongoing follow-up cooperation at the time of the ex-post evaluation would confirm the situation of these defects to the extent possible and propose countermeasures.

[Mobile Drainage Pumps]

According to DPWH, one mobile drainage pump was out of order at the time of the ex-post evaluation and two were under repair.

(2) Effect Indicators

[Real-time Earthquake and Tsunami Monitoring System Sets]

Table 5 shows the target achievements of the project effect indicators set at the time of ex-ante evaluation, according to PHIVOLCS and DPWH.

"1) Percentage of issuing moment magnitude[4] and epicenter information within 15 minutes after earthquakes of M4.5 and above" has not reached the target value of 60%, and according to PHIVOLCS, there is still a problem with the accuracy of the calculation. However, although there are still issues, compared to before project implementation, the project equipment has enabled the measuring and recording of large ground tremors, grasping of the magnitude epicenter, and more precise information of massive earthquakes, which are effects of this project.

Regarding "2) Time required for magnitude calculation of very large earthquakes useful for tsunami information and potential earthquake damage evaluation," there is no actual value as no massive earthquake has occurred since project completion. With the installation of the broadband strong-motion seismometer, the tsunami waveform of a huge earthquake can now be promptly transmitted to the headquarters. According to PHIVOLCS, the system allows for calculation within 15 minutes.

Regarding "3) Time required for confirmation of local tsunami after detection or observation of first tsunami wave," although the target value of less than 1 minute was not achieved, considering that the time taken before the project was 30 minutes to several hours, the project has clearly had the effect of speeding up tsunami wave detection. Prior to the implementation of this project, PHIVOLCS used the tide gauge of the National Mapping and Resource Information Agency (NAMRIA) to detect tsunamis, but this was for map creation and did not allow tsunami information to be grasped in real-time.

Regarding indicators 1) to 3), as mentioned in (1) Operational Status, there were 7 locations where the broadband strong-motion seismometers installed in this project were not operating and 7 locations where the tsunami wave detectors were also out of service at the time of the ex-post evaluation. Given that the equipment was expected to be in full operation and that the target value has not been achieved, the effect has also not been achieved. However, the indicators had improved compared to before project implementation. In hearings from the implementing agency of the SATREPS project and PHIVOLCS, guidance had been given in advance to improve monitoring and analysis capabilities using the earthquake and tsunami monitoring equipment of the SATREPS project also employed in this project. Improvement in

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[4] An earthquake occurs when the underground rock is displaced, and the magnitude of the earthquake is calculated based on the scale of the displacement (area of the fault surface x displacement of the fault x hardness of the rock). This is called the moment magnitude. In general, the magnitude is calculated from the amplitudes of seismic waves recorded by seismographs, while the moment magnitude is effective for measuring large earthquakes. However, complex calculations using high-performance seismograph data are required to obtain the value. (https://www.jma.go.jp/jma/kishou/know/faq/faq27.html#8 Japan Meteorological Agency website / August 2021)

the earthquake and tsunami monitoring capabilities of PHIVOLCS staff, which is the purpose of this project, has been observed compared to the situation before the project.

Regarding "4) Number of tsunami simulation cases that can be processed per 6 hours," although the consultants of this project, PHIVOLCS, and those involved in the SATREPS project were questioned about the basis for setting the target value of 400 cases, the reason could neither be confirmed nor evaluated. According to those concerned, the number of cases was most likely based on the calculation capacity of the simulation software and the high-performance PC cluster (10 PCs) installed with the tsunami simulation database development hardware set. PHIVOLCS did not perform such simulation calculations, and the software introduced by this project does not use multiple PCs simultaneously but simulates on a single PC. According to PHIVOLCS, the SATREPS project has already accumulated a considerable number of tsunami simulation cases, but since there has never been a tsunami caused by a large-scale earthquake, there is no record or number of simulation cases. So far, it has not been used for training purposes either. At the time of the ex-post evaluation, some of the PCs procured in this project had already been updated by PHIVOLCS.

Table 5: Project Effect Indicators

| **Indicators** | **Baseline (2012)** | **Target (2018) (3 years after completion)** | **Actual (July 2021)** |
|---|---|---|---|
| 1) Percentage of issuing moment magnitude and epicenter information within 15 minutes after earthquakes of M4.5 and above | 2% | 60% | <u>43%</u><br>Percentage of issuing earthquake information (usual magnitude) of M4.5 and above within 15 minutes is 90% and more to total number of earthquakes every year from 2018 to 2020. Moment magnitude of M4.5 and above are calculated daily, however they are not always disclosed due to problems with calculation accuracy. Also, moment magnitude is calculated when sufficient stations can transmit waveform data to the center and then the usual magnitude information is later replaced with moment magnitude. PHIVOLCS has commissioned and incorporated other broadband stations to the system to improve the calculation. . |
| 2) Time required for magnitude calculation of very large earthquakes useful for tsunami information and potential earthquake damage evaluation | N/A | Less than 15 minutes | <u>Within 15 minutes</u><br>The maintenance of the equipment is said to have made it possible to achieve the target value, but as there has been no huge earthquake that would cause a tsunami since equipment installation, the actual results have not been confirmed. |
| 3) Time required for confirmation of local tsunami after detection or observation of first tsunami wave | 30 minutes to several hours | Less than 1 minute | <u>Less than 1 minute</u><br>Only cases of small waves (less than 1m) had occurred up until the time of the ex-post evaluation. |

| Indicators | Baseline (2012) | Target (2018) (3 years after completion) | Actual (July 2021) |
|---|---|---|---|
| 4) Number of tsunami simulation cases that can be processed per 6 hours | 1 case | 400 cases | According to PHIVOLCS, the SATREPS project calculated and accumulated a considerable number of tsunami simulation cases. It would be possible to perform simulations using the PC cluster of this project, or to install analysis software on each PC and run multiple PCs at the same time to calculate many cases, but there is no record of such simulations being performed. |
| 5) Time required for pumping out inland flood in urban areas | Approx. 3 days | Approx. 1 day | Within 1-8 hours depending on the location |

Source: JICA documents, Questionnaire answers from executing agencies

[Mobile Drainage Pumps]

The time required for mobile drainage pumps to drain varies from 1 to 8 hours, depending on the flood damage in each region. However, the actual results up to the time of the ex-post evaluation show that the targeted drainage within one day had been achieved in pumping out inland water in urban areas.

3.3.1.2 Qualitative Effects (Other Effects)

According to PHIVOLCS, the following points were pointed out as qualitative effects. Earthquake and tsunami information is provided to domestic and overseas disaster prevention related organizations (Office of Civil Defense of the Department of National Defense, National Disaster Risk Reduction and Management Council, and South China Sea Tsunami Advisory Center (SCSTAC)).

[Strengthening Earthquake Monitoring Capacity]

The earthquake monitoring network has been strengthened to disseminate monitoring information when an earthquake is detected. For earthquakes of M4.5 and above, details of moment magnitude and occurrence status are now summarized in the earthquake status report, providing vital information on whether aftershocks should be expected during rescue operations in the affected area.

Data from operating tsunami wave detectors is also provided to other governmental organizations to help monitor volcanic activity and typhoon tracks. For example, a water level survey by the Nasugbu, Bauan, and Batangas Maritime Bureaus in the first half of 2020 revealed that changes in water levels could be associated with Taal volcanic activity at that time. Sea level data was also provided to NAMRIA in regard to the course of typhoons in the Philippines.

[Strengthening Tsunami Monitoring Capacity]

Although there have been no major earthquakes that have generated tsunamis up until now, PHIVOLCS evaluates the threat of tsunamis and issues tsunami information when small tsunamis occur due to maritime earthquakes. For tsunami monitoring, tsunami simulation software is now used to perform real-time tidal current analysis in cooperation with NAMRIA. In addition, this project has allowed earlier detection of tsunamis and more accurate calculations of tsunami conditions, and, as a result, it has become possible to give more precise instructions through the early warning system on the occurrence of a tsunami.

### 3.3.2 Impacts

#### 3.3.2.1 Intended Impacts

Regarding the impact of "contributing to reducing human and economic damage caused by disasters such as earthquakes and tsunamis," according to DPWH, mobile drainage pumps are removing excess water from drainage channels during floods to minimize flood areas.

At DPWH's San Fernando office, the project's mobile drainage pumps are the only ones in the area and are used during major floods on Manila North Road in Pampanga. The site is near a commercial complex, and without a mobile drainage pump, significant damage could be caused by floods. When a big disaster occurs in Metro Manila, the mobile drainage pump of the San Fernando regional office will be used. The mobile drainage pumps located in Metro Manila have helped to pump out water at drainage pump stations. At the DPWH Davao branch, mobile drainage pumps are also used to clear gutters and help prevent floods.

Mobile drainage pumps have also been used as an emergency power source in a disaster, which is an example of other usages. DPWH's regional office on Leyte Island used them as a power source for offices when a magnitude 6.5 earthquake occurred in July 2017 and as a power source for the Maintenance Division in the Ursula typhoon in December 2019. In March 2021, they were used as a standby power source for the hotel where the country's president was staying.

#### 3.3.2.2 Other Positive and Negative Impacts

The mobile drainage pumps conducted quick drainage, which aided the smooth flow of road traffic. No other major positive and negative impacts have been confirmed.

Among the equipment of this project, the data transmission problem of PHIVOLCS's earthquake intensity meter and tsunami wave detector, which was discovered after project completion, remained unresolved at the time of the ex-post evaluation. With travel restrictions in various places due to the spread of COVID-19, some of the other equipment is also out of service because batteries and parts cannot be replaced, or the equipment malfunction needs to be handled onsite.

However, much of the equipment, other than the uninstalled earthquake intensity meters, has been operating, which has helped provide information to each disaster response organization. Some DPWH mobile drainage pumps were under repair at the time of the ex-post evaluation. Still, they are helping with the recovery of flooded sites or preventing floods, therefore contributing to reducing human and economic damage. This project has achieved its objectives to some extent. Thus, the effectiveness and impacts of the project are fair.

### 3.4 Sustainability (Rating: ②)

#### 3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

It is considered that the organizational structure required for the operation and maintenance of the project's equipment is sustainable to a certain point.

At PHIVOLCS, the Seismological Observation and Earthquake Prediction Division (SOEPD) manages the operation and maintenance of the equipment procured by the project, as in the ex-ante evaluation, and the number of staff is 71. According to SOEPD, the organizational structure is partially sufficient. New technical staff are needed for more effective maintenance, and PHIVOLCS technical staff directly supervise and employ personnel to carry out the designated technical work, although only for a specific period. In addition, automated data processing is being promoted to review daily monitoring tasks, to reduce workload and minimize human error.

According to those in charge of the operation and maintenance of the DPWH mobile drainage pumps, the equipment management unit of each regional office equipped with a mobile drainage pump has about six staff members, and DPWH's self-evaluation shows that this number is sufficient. DPWH has assigned the necessary staff for mobile drainage pumps, and no problems have been observed.

#### 3.4.2 Technical Aspects of Operation and Maintenance

No problems have been observed in the technical aspects of this project's equipment operation and maintenance on a daily level.

According to PHIVOLCS's self-evaluation, there was an operation and maintenance orientation given by the supplier and technology transfer from the contractor to specific staff members. Still, as those staff members have gradually been promoted or have retired, technology transfer has been inadequate for the troubleshooting skills of new staff members. Regarding this, each unit has begun to identify the necessary technology and replenish personnel by outsourcing.

DPWH self-evaluates that the technical capabilities of the mobile drainage pump engineers and mechanics are sufficient. Preventive maintenance is carried out based on the annual maintenance schedule and budget, and since the staff have good knowledge of maintenance and training, there seem to be no technical issues.

### 3.4.3 Financial Aspects of Operation and Maintenance

The budget required for the daily operation and maintenance of the project equipment is generally provided.

According to PHIVOLCS SOEPD, the annual operation and maintenance budgets after 2017 were between 6-8 million Philippine pesos. The budget covers the daily operation and maintenance costs, such as the procurement of spare parts and repairs. According to answers to the questionnaire provided by the DPWH headquarters and each regional office, the annual budget required for the maintenance of the mobile drainage pumps is allocated to the maintenance unit of each regional office.

### 3.4.4 Status of Operation and Maintenance

The operational status of each piece of equipment at the time of the ex-post evaluation was as shown in Table 4. Regarding the equipment of PHIVOLCS, when the equipment under the jurisdiction of PHIVOLCS Headquarters, Region VIII Regional Office (Leyte Island), and Region X Regional Office (Mindanao Island) was inspected onsite, all were operating without problems.

DPWH's mobile drainage pumps were directly inspected at two locations in Metro Manila, the Pampanga Regional Office, the Leyte Island Regional Office, and the Davao Regional Office. The mobile drainage pump located in Davao was out of order, as reported in the response to the questionnaire, but the others were in operation. The mobile drainage pump located in Bicutan in Metro Manila had one faulty submersible pump, but the other one was in operation.

The operation and maintenance status of the equipment confirmed at the time of the ex-post evaluation is as follows.

- According to PHIVOLCS, the budget for daily maintenance is covered but it is difficult to obtain spare parts from the supplier when needed.
- Some of the replacement batteries and parts have already been procured, but due to the spread of COVID-19, access to the site is restricted, and at the time of the ex-post evaluation (August 2021), replacements had not yet been completed. As the delivery procedure has already been initiated, the amount of equipment reoperating should increase once the replacement of batteries and parts takes place at the sites.
- Regarding the two mobile drainage pumps under repair, the pumps are being repaired in Laguna, and the inverters and drainage pumps are being repaired in Davao. Replacing the hose of the drainage pump requires time, as the hose cannot be procured in the Philippines.

As mentioned above, a certain degree of sustainability has been observed in the institutional aspects, technical aspects, and financial aspects of the operation and maintenance system. However, some equipment is not in operation due to defects or breakdowns, the JICA follow-up cooperation was still underway at the time of the ex-post evaluation, and measures such as the procurement of spare parts are also still being implemented. Therefore, the status of improvement cannot yet be confirmed. As some minor problems have been observed in the institutional aspects, technical aspects, and financial aspects of the operation and maintenance system, the sustainability of the project effects is fair.

# 4. Conclusion, Lessons Learned and Recommendations

## 4.1 Conclusion

This project aimed to improve the monitoring capacity for earthquakes and tsunamis and drainage measures by installing monitoring equipment for earthquakes and tsunamis and mobile drainage pumps throughout the Philippines, therefore reducing the human and economic damage caused by such disasters. The implementation of the project was well in line with the development policy and development needs of the Philippines and Japan's ODA plan and is highly relevant. The efficiency is fair because both the project cost and the project period exceeded the plan. Of the equipment maintained through this project, problems with PHIVOLCS data transmission of the earthquake intensity meter and tsunami wave detector had not been resolved at the time of the ex-post evaluation. As for other equipment, due to the spread of COVID-19, travel restrictions in various locations made it difficult to replace batteries and parts and to deal with equipment malfunctions, and therefore some of the equipment seems not to be operating. However, the equipment has contributed to speedy observations and improved information on earthquakes and tsunamis in the past. As for the mobile drainage pumps of the DPWH have helped prevent flood damage or recovery after flood disasters through drainage, contributing to a reduction in human and economic damage. For these reasons, the effectiveness and impact are considered fair as a certain effect of the implementation of the project has been observed. Although sustainability was observed to a certain degree in terms of the institutional/organizational, technical, and financial aspects of the operation and maintenance system, at the time of the ex-post evaluation, there were some problems with equipment operation due to defects or failures. Therefore, the sustainability of the project effects is fair.

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

## 4.2 Recommendations

### 4.2.1 Recommendations to the Executing Agency

(DPWH)

As with PHIVOLCS, it takes time for regional offices to procure parts. For parts that can be replaced in advance, such as batteries, a spare parts management plan for each site should be reviewed to include early replacement at the timing of regular inspections.

#### 4.2.2 Recommendations to JICA

For equipment that is not operating, such as PHIVOLCS earthquake intensity meters and tsunami wave detectors, JICA should support coordination with all Japanese parties (including follow-up cooperation implementers, equipment developers, manufacturers, etc.) through the follow-up cooperation underway in FY2021, in order to promote the implementation of countermeasures, and aim for early operation.

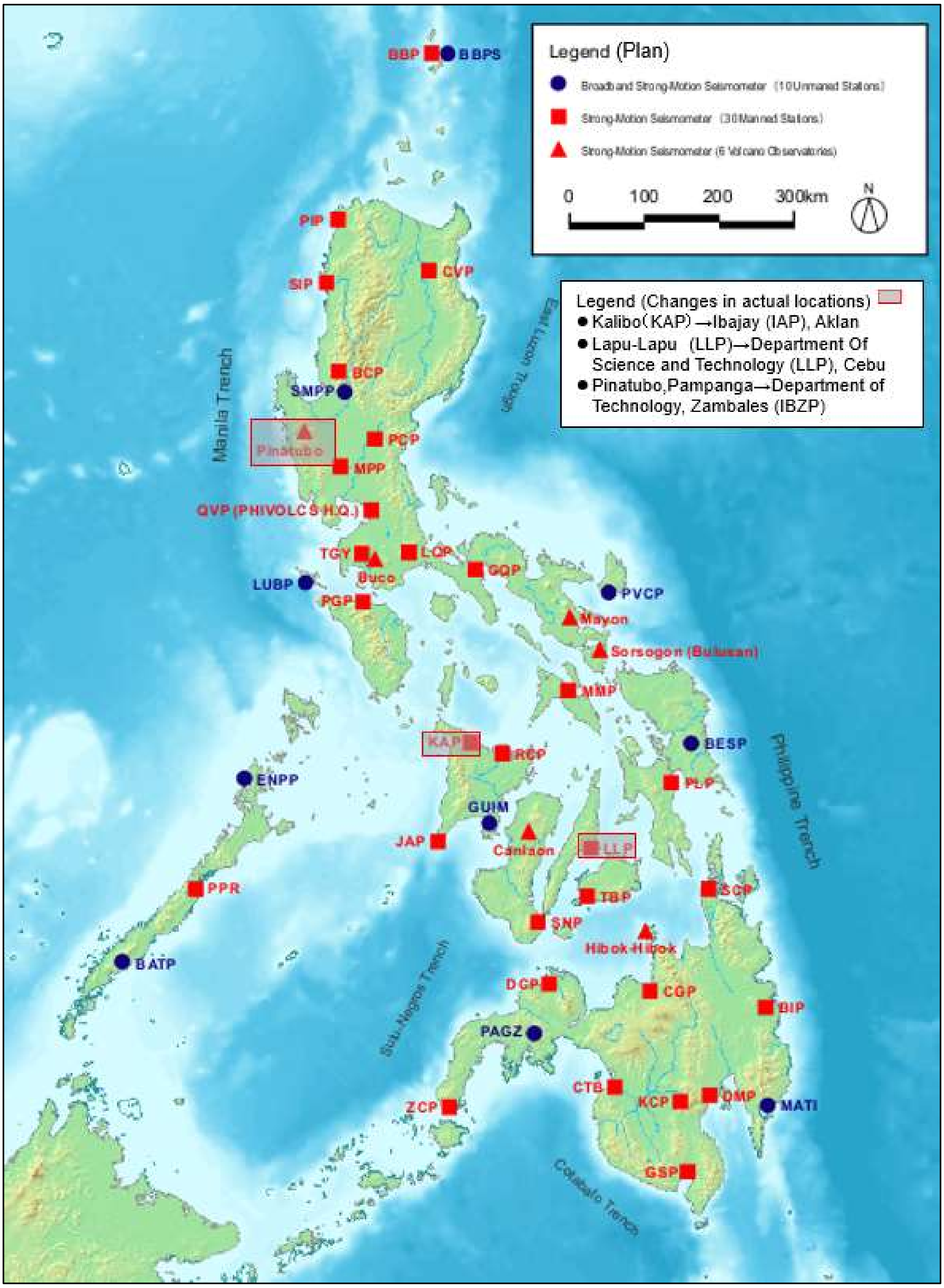
### 4.3 Lessons Learned

Early Identification and Consideration of Countermeasures for Communication Infrastructure Risks in Building Data Transmission Networks

For the operation of PHIVOLCS earthquake and tsunami monitoring equipment sets, the communications system is a prerequisite and is a requirement for proper functioning. There are various issues to be examined, such as forecasting the development of communication systems and the compatibility between evolving communication equipment and existing equipment. Adopting the right outlook for this is a challenge. In addition, when building a wide-ranging data transmission network in an island country such as the Philippines, that includes less-accessible areas, problems unique to each region can be expected, each requiring more careful consideration and a different implementation structure.

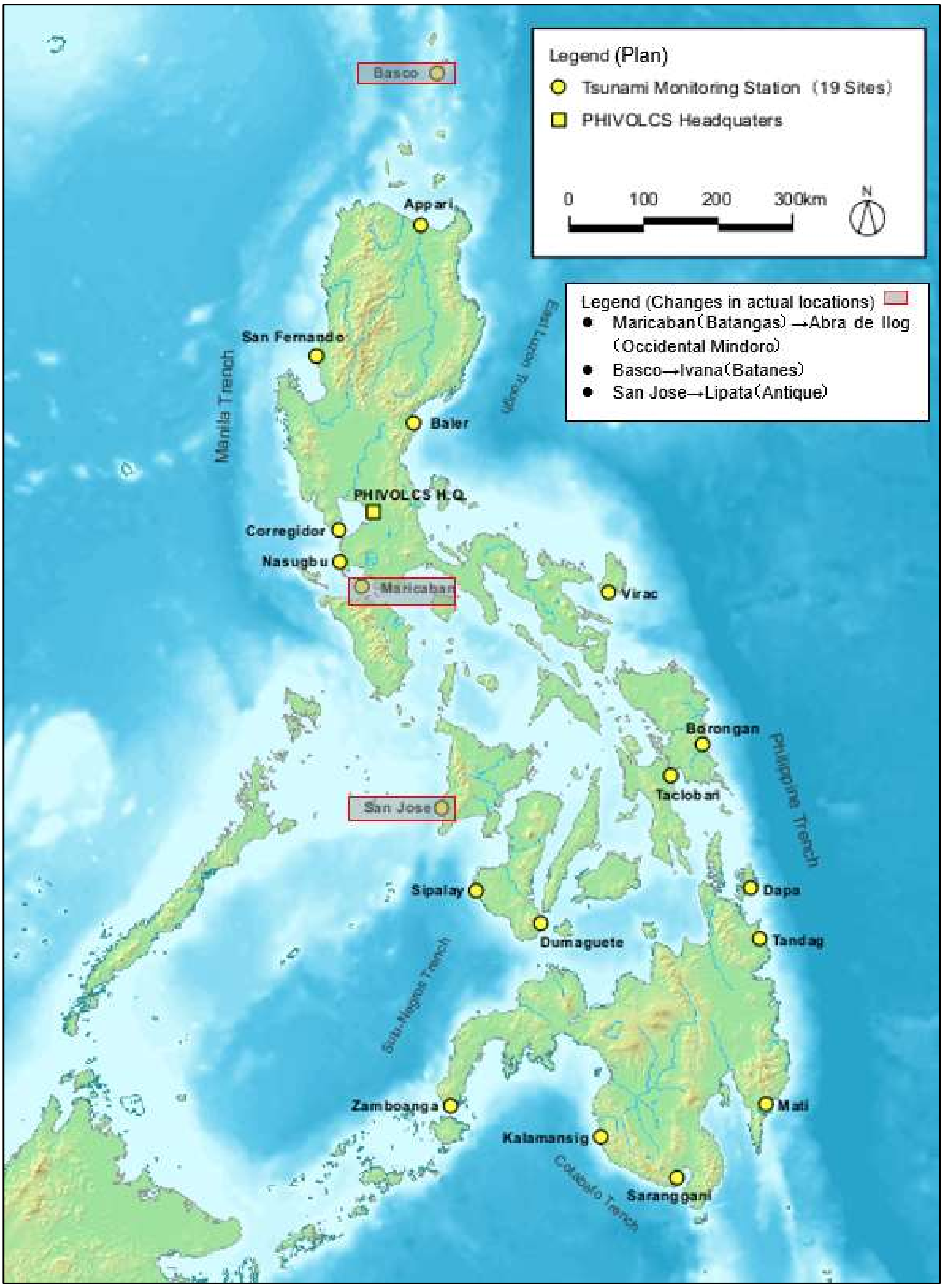
Detailed consideration of assumed risks and the presentation of countermeasures when risks occur should be included at the stage of the preparatory survey. The project plan during the project implementation period can include the soft component in terms of : (1) Including support for equipment installation and communication tests, (2) Identifying risks that may occur after equipment installation and proposing countermeasures, (3) For communication equipment such as that used in this project, a location for equipment suppliers to inspect the operation should be selected with consideration to the differences in communication environments and the supplier should conduct inspections more carefully with a longer inspection period.

End



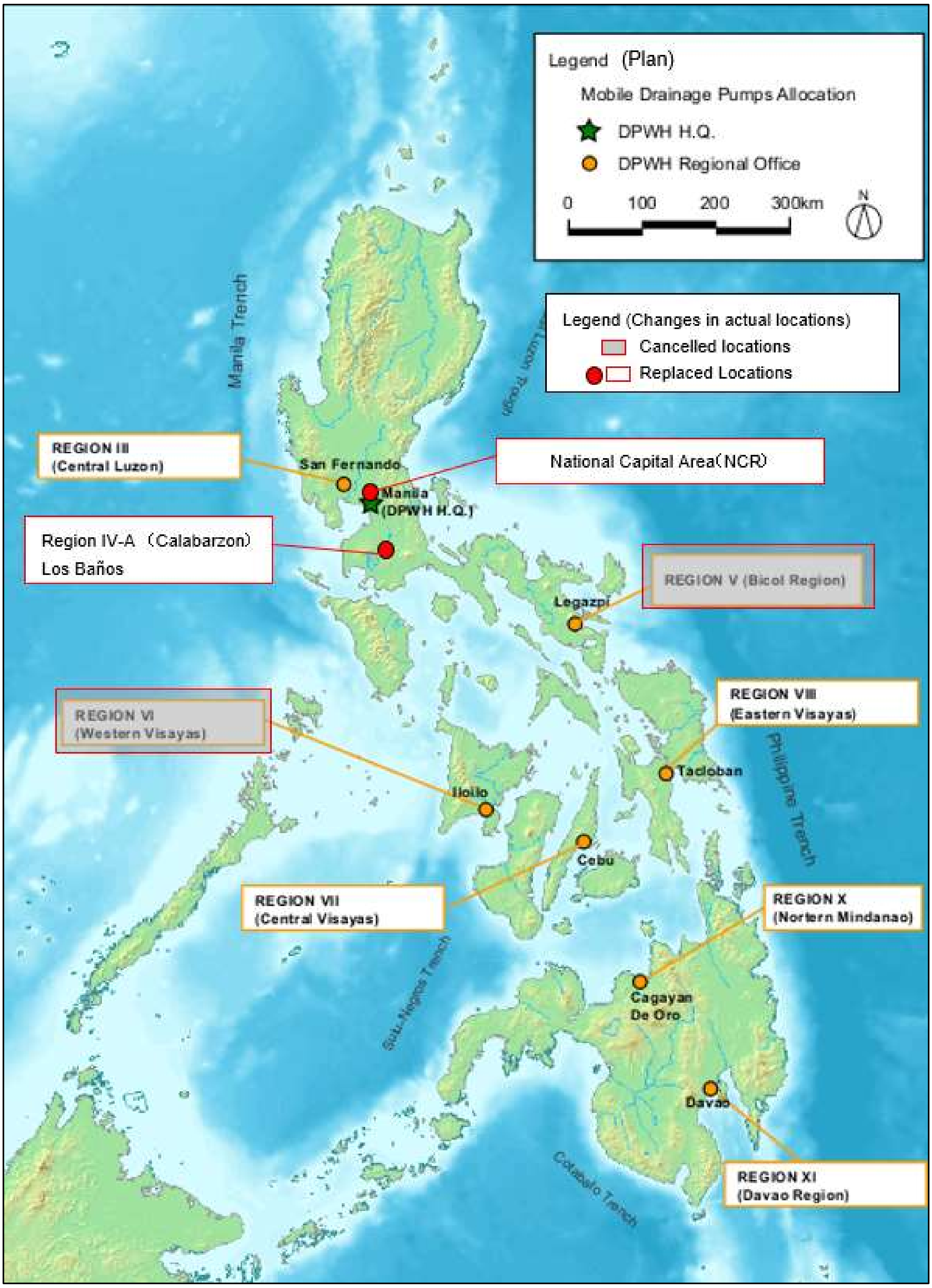

Source: JICA "Preparatory Survey Report on the Project for Improvement of Equipment for Disaster Risk Management in Republic of The Philippines" (2013). Actual locations were from other JICA documents.

Attached Map 1: Target Sites of PHIVOLCS Realtime Earthquake Monitoring System




Source: JICA "Preparatory Survey Report on the Project for Improvement of Equipment for Disaster Risk Management in Republic of The Philippines" (2013). Actual locations were from other JICA documents.

Attached Map 2: Target Sites of PHIVOLCS Realtime Tsunami Monitoring System




Source: JICA "Preparatory Survey Report on the Project for Improvement of Equipment for Disaster Risk Management in Republic of The Philippines" (2013). Actual locations were from other DPWH and JICA documents.

Attached Map 3: Target Sites of DPWH Mobile Drainage Pumps