

Country Name		Strengthening of Flood Forecasting and Warning System for Dam Operation													
Republic of the Philippines															
I. Project Outline															
Background	<p>The central and northern parts of Luzon Island is usually hit by about three to five typhoons every year affecting dam operations which supply electricity, irrigation water and drinking water to many areas including Metro Manila. To mitigate flood damages brought about by dam operations, the Government of the Philippines (GOP) in the 1980s installed a Flood Forecasting and Warning System for Dam Operation (FFWSDO) through the Official Development Assistance (ODA) of the Government of Japan (GOJ) in five dam sites (Ambuklao and Binga dams in the Agno River basin, Magat dam in the Cagayan River basin, Angat and Pantabangan dams in the Pampanga River basin). However, most of the donated flood forecasting equipment became non-functional especially after the volcano eruptions and devastating earthquakes in early 1990s<sup>1</sup>. This affected the service delivery of the National Irrigation Administration (NIA) and the National Power Corporation (NPC) which are responsible for flood forecasting and warning in the upstream areas of the river basins. The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), is responsible for the Flood Forecasting and Warning System (FFWS) in the middle and downstream areas of the river basins. In order to strengthen the capability of flood forecasting and warning at the middle and downstream areas in the Agno, Magat/Cagayan, Pampanga, and Bicol river basins, JICA assisted PAGASA in implementing a technical cooperation project titled, “Strengthening of Flood Forecasting and Warning Administration” from 2004 to 2006. Through this project, the capability of PAGASA in issuing forecasting and warning in the middle and downstream areas in the Agno, Magat/Cagayan, Pampanga, and Bicol river basins was strengthened. However, the capability of issuing flood forecasting and warning in the upstream areas was still insufficient, making the overall capability of flood forecasting and warning for the entire river basins inadequate.</p> <p>In addition to the above five dams, this project targeted the San Roque dam constructed in the Agno River basin in 2003 under another Japanese ODA project.</p>														
Objectives of the Project	<p>The project was aimed at improving capability in flood forecasting and warning for proper dam operation by collecting and analyzing meteorological and hydrological data, strengthening information and knowledge sharing among Joint Operation and Management Committee (JOMC) members and local government units (LGUs), and strengthening capability in operation and maintenance (O&amp;M) of meteorological and hydrological equipment of the above rivers, thereby contributing to reduction of loss and damages caused by floods. The project objectives set forth are as follows:</p> <ol style="list-style-type: none"><li>Overall Goal: Loss and damage caused by floods within Pampanga, Agno and Cagayan River Basins are reduced.</li><li>Project Purpose: Capability in flood forecasting and warning for proper dam operation in the dam target areas along Pampanga, Agno, Angat and Magat/Cagayan Rivers is improved.</li></ol>														
Activities of the project	<ol style="list-style-type: none"><li>Project site: Metro Manila, and the provinces of Bulacan, Pampanga, Pangasinan, Nueva Ecija, Benguet, Isabela and Nueva Vizcaya Targeted dams: Magat dam (Cagayan River basin), Ambuklao/Binga and San Roque dams (Agno River basin), and Pantabangan dam and Angat dam (Pampanga River basin)</li><li>Main activities: (1) Develop hydrological and river cross sections databases including basic survey on the downstream of the target dams and simulation models for flood inundation analysis in the Pampanga River basin; (2) Conduct training of staff to strengthen dam discharge warning and flood information dissemination and strengthen information and knowledge sharing among JOMC members and relevant organizations; and (3) Conduct maintenance and replacement of observation and warning equipment and train staff for O&amp;M system for observation and warning equipment etc.</li><li>Inputs (to carry out above activities)<table><tr><td>Japanese Side</td><td>Philippine Side</td></tr><tr><td>1) Experts: 5 persons</td><td>1. Staff allocated: 50 persons</td></tr><tr><td>2) Trainees received: 14 persons</td><td>2. Office space with basic office equipment and utilities</td></tr><tr><td>3) Equipment: water level telemetry sub-system, portable testing instruments etc.</td><td>(water, electricity, office supplies)</td></tr><tr><td>4) Local expenses</td><td></td></tr></table></li></ol>					Japanese Side	Philippine Side	1) Experts: 5 persons	1. Staff allocated: 50 persons	2) Trainees received: 14 persons	2. Office space with basic office equipment and utilities	3) Equipment: water level telemetry sub-system, portable testing instruments etc.	(water, electricity, office supplies)	4) Local expenses	
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Ex-Ante Evaluation	2007	Project Period	October 2009 – November 2012	Project Cost	(ex-ante) 280 million yen (actual) 370 million yen										
Implementing Agency	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in collaboration with the National Irrigation Administration (NIA) and the National Power Corporation (NPC)														
Cooperation Agency in Japan	Ministry of Land Infrastructure, Transportation and Tourism														

<sup>1</sup> Under such situation, the Project for Improvement of Flood Forecasting and Warning System in the Pampanga and Agno River Basins (2007-2011, Japan's Grant Aid) was implemented to procure telemetry subsystem, data processing subsystem and backbone telecommunication subsystem etc.

## II. Result of the Evaluation

### 1 Relevance

<Consistency with the Development Policy of the Philippines at the time of ex-ante evaluation and project completion>

The project has been consistent with the Philippine's development policy on 'reduction of damages from natural disasters' and 'strengthening of disaster prevention against typhoon and floods' etc. as set forth in "the Medium-Term Philippine Development Plan (MTPDP)(2004-2010)", the "National Science and Technology Plan (NSTP)(2002-2020)" and the "Philippine Development Plan (PDP)(2011-2016)".

<Consistency with the Development Needs of the Philippines at the time of ex-ante evaluation and project completion>

At the time of ex-ante evaluation (in 2007), project counterparts (C/P) trained under Japan's ODA projects during the 1980s had either retired from government service or had left C/P organizations, thus the lack of capacities of new staff in C/P organizations in flood forecasting and warning was evident. PAGASA, NIA and NPC have continuously been the main actors in Philippines' FFWSO up to the present including at the time of project completion.

<Consistency with Japan's ODA Policy at the time of ex-ante evaluation>

The project was consistent with Japan's ODA policy on 'environmental protection and disaster prevention', as stated in one of the four priority areas of the Country Assistance Program for the Philippines (2008). With regards to disaster management, assistance for natural disaster mitigation (flood, earthquake and volcanic disaster etc.) was also a priority area.

<Evaluation Result>

In light of the above, the relevance of the project is high.

### 2 Effectiveness/Impact

<Status of Achievement for the Project Purpose at the time of Project Completion>

The Project Purpose was mostly achieved by the time of project completion. Improvements in timeliness and accuracy of dam discharge and flood warning issuance as well as better reach of the warnings to the communities were reported during typhoons in 2011, compared with the situation during typhoons in 2009 (Indicator 1). Based on the drills conducted by the project, NPC and SN Aboitiz Power Company (SNAP) conducted flood warning drills in May 2012 so that project activities would be continued even after project completion (Indicator 2). Updated Dam Discharge Warning Manual (UDDWM) and Updated Flood Warning Manual for Dam Target Areas (UFWM) were drafted and reviewed by PAGASA, NPC and NIA (Indicator 3).

<Continuation Status of Project Effects at the time of Ex-post Evaluation>

The generation of positive project effects has been partially maintained after project completion. Four to six major typhoons hit central and northern Luzon every year thereafter. Dam discharge information and flood warnings during these major typhoons have been issued timely and accurately by the dams to downstream communities. Seventy-eight percent of the 55 beneficiary interview respondents<sup>2</sup> (consisting of barangay<sup>3</sup> officials and residents) in the downstream barangays of Magat, Ambuklao, Binga, Pantabangan, San Roque and Angat dams reported that dam discharge and flood warnings have been issued timely and accurately in the last three years. The hydrological database, dam inflow and dam downstream forecasting models for river basins developed under the project have been continuously utilized by PAGASA, NPC and NIA as references in issuing dam discharge and flood warnings. Although some of the existing rain gauges are malfunctioning, this has never compromised the operation of the flood forecasting and warning system developed by the project. PAGASA, NIA and NPC have other equipment they can use whenever equipment provided by the project breaks down. Also, power-generating private companies operating in the dam sites have their own equipment with which rainfall data and flood forecasting information are always shared with FFWSO staff of PAGASA, NIA and NPC. At the time of ex-post evaluation, NPC and NIA are in the process of procuring spare parts and replacing non-functional rain gauges, respectively. NIA, in particular, has already installed additional rain gauges for Magat dam. Regarding trainings, LGUs located within the immediate periphery of the dams, such as the provinces of Cagayan, Isabela, Benguet, Pangasinan and Bulacan, through their respective Local Disaster Risk Reduction Offices (LDRRMOs), have regularly conducted disaster risk management seminars including evacuation drills in compliance with existing laws on Disaster Risk Reduction Management (DRRM) and Climate Change Adaptation. PAGASA, NPC and NIA have regularly participated in these seminars and drills to disseminate information about FFWSO. In addition, flood information dissemination seminars have been conducted separately by PAGASA, NPC, NIA and LDRRMOs of LGUs once a year, usually before the onslaught of the rainy season. Regarding manuals, UDDWM and UFWM have been reviewed and approved individually by PAGASA, NPC and NIA, and have been continuously utilized by these organizations in flood forecasting and in issuing flood warnings<sup>4</sup>. The manuals have been approved by PAGASA, NIA and NPC but the National Water Resources Board (NWRB) was not able to sign the manuals due to some differences in perspectives about the contents. In the case of NIA-Pantabangan, the manuals was revisited together with PAGASA and accordingly made revisions on the contents and forms which are currently utilized. However, flood operation rule is yet to be used due to its pending approval. Regarding utilization of meteorological and hydrological equipment, three of the six water level equipment at the dams/reservoirs procured and/or replaced under the project are no longer operational due to lightning strike or system misconfiguration etc. Thus, NPC has included in its procurement plan the purchase of three additional encoders and one water level sensor of these water level equipment.

<Status of Achievement for Overall Goal at the time of Ex-post Evaluation>

The Overall Goal has been partially achieved at the time of ex-post evaluation. River basin-wide data on the number of victims and economic losses due to floods from dam operations are not available. But provincial data reveal that the number of victims and the amount of economic losses have indeed been reduced between project commencement and ex-post evaluation (e.g., Pangasinan province). 43 of 55 respondents (78%) of the beneficiary survey reported that the NIA/NPC flood warnings in recent flood events had indeed saved more lives of people and working animals.

<Other Impacts at the time of Ex-post Evaluation>

<sup>2</sup> Representation is limited as the sample size is small due to limitations in evaluation period.

<sup>3</sup> A barangay is the smallest local administration unit.

<sup>4</sup> At the time of ex-post evaluation, NIA and NPC are considering of updating UDDWM and UFWM to include "dam break scenarios" based on results of evacuation drills for downstream communities of project-targeted dams, and also in consideration of the privatization of the power component of the dam operations.

No negative impact on natural environment has been observed. The project did not entail land acquisition and resettlement issues.  
<Evaluation Result>

Targets set in indicators for the Project Purpose were mostly achieved. The project effects have been partially maintained since project completion. At the time of ex-post evaluation, the Overall Goal is judged partially attained because of insufficient verifiable data on the number of victims and economic losses due to flood events in the dams in the entire river basins. Therefore, the effectiveness/impact of the project is fair.

Achievement of project purpose and overall goal

Aim	Indicators	Results																										
(Project Purpose) Capability in flood forecasting and warning for proper dam operation in the dam target areas along Pampanga, Agno, Angat and Magat/Cagayan Rivers is improved.	1. Dam discharge and flood warnings are issued timely and accurately to all affected communities.	Status of the achievement: achieved (mostly continued) (Project Completion) Compared with the situation during the typhoons in September 2009 (Pepeng and Ondoy) and the typhoons in September 2011 (Pedring and Quiel), improvements in timeliness and accuracy of dam discharge and flood warning issuance and better reach of the warnings to the communities (barangays) were reported by staff of dam offices, PAGASA, downstream local governments and communities. Dam inflow and forecasting models formulated by the project improved the accuracy of capturing the data for discharge volume and water level as well as locations of floods at any given time. (Ex-post Evaluation) Dam discharge and flood warnings during major typhoons in 2013, 2014 and 2015 were issued timely and accurately to downstream communities of Magat, Ambuklao, Binga, San Roque and Angat dams except for Pantabangan dam <sup>5</sup> . The hydrological database and dam inflow and dam downstream forecasting models for Magat/Cagayan, Agno, Angat, Upper Pampanga river basins developed by the project have been continuously utilized by PAGASA, NPC and NIA in issuing dam discharge and flood warnings. The non-functionality of some of the existing staff gauges did not hamper the operations of the flood forecasting and warning system for dam operations.																										
	2. Dam discharge warning and flood information dissemination training is continuously conducted by the responsible organizations.	Status of the achievement: mostly achieved (continued) (Project Completion) Based on the dam discharge warning and flood information dissemination drills conducted by the working group, a flood warning drill was conducted in Binga dam by the initiative of NPC and SNAP in May 2012. They also conducted prior consultations to LGUs and downstream communities as well as evaluation meetings. (Ex-post Evaluation) Local Disaster Risk Reduction Management Offices (LDRRMOs) of Local Government Units (LGUs) located within the immediate periphery of all targeted dams have regularly conducted disaster risk management seminars including evacuation drills in compliance with existing laws on Disaster Risk Reduction Management (DRRM) and Climate Change Adaptation. In addition, flood information dissemination seminars have been conducted by PAGASA, NPC, NIA and LDRRMOs of LGUs once a year, usually before the onslaught of the rainy season.																										
	3. Revised warning guideline is prepared.	Status of the achievement: achieved (mostly continued) (Project Completion) UDDWM and UFWM were drafted and reviewed by PAGASA, NPC and NIA. (Ex-post Evaluation) UDDWM and UFWM have been reviewed and approved individually by PAGASA, NPC and NIA, and have been continuously utilized by these organizations in flood forecasting and in issuing flood warnings. These manuals have not been approved yet by the National Water Resources Board (NWRB) which is supposed to consolidate water resource-related policies. Nevertheless, its non-approval does not prevent PAGASA, NPC and NIA to utilize these manuals.																										
	(Supplemental Information) Whether the water level equipment have been continuously utilized at the six dams/reservoirs since project completion.	Status of the achievement: achieved (partially continued) (Ex-post Evaluation) The table below shows the number of operational equipment among the total number of water level equipment. <table><tr><td></td><td>Before October 2009</td><td>As of October 2012</td><td>At the time of ex-post evaluation</td></tr><tr><td>Magat Dam</td><td>0/1</td><td>1/1</td><td>1/1</td></tr><tr><td>Ambuklao/Binga Dam</td><td>2/2</td><td>2/2</td><td>1/2</td></tr><tr><td>San Roque Dam</td><td>0/0</td><td>1/1</td><td>0/1</td></tr><tr><td>Pantabangan Dam</td><td>0/1</td><td>1/1</td><td>1/1</td></tr><tr><td>Angat Dam</td><td>0/1</td><td>1/1</td><td>0/1</td></tr></table>		Before October 2009	As of October 2012	At the time of ex-post evaluation	Magat Dam	0/1	1/1	1/1	Ambuklao/Binga Dam	2/2	2/2	1/2	San Roque Dam	0/0	1/1	0/1	Pantabangan Dam	0/1	1/1	1/1	Angat Dam	0/1	1/1	0/1		
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Pantabangan Dam	0/1	1/1	1/1																									
Angat Dam	0/1	1/1	0/1																									
(Overall goal) Loss and damage caused by floods within Pampanga, Agno and Cagayan River Basins are reduced.	Number of victims and economic loss at the event of the floods	(Ex-post Evaluation) partially achieved The table below shows destructive damages caused by typhoons in Pangasinan province. <table><tr><td rowspan="2">Year</td><td colspan="3">Casualties</td><td colspan="2">Damaged Properties (Million Pesos)</td><td rowspan="2">Total Cost of Damage (Million Pesos)</td></tr><tr><td>Dead</td><td>Injured</td><td>Missing</td><td>Agriculture</td><td>Infrastructure</td></tr><tr><td>2009</td><td>105</td><td>26</td><td>5</td><td>4,180</td><td>2,581</td><td>6,761</td></tr><tr><td>2010</td><td>11</td><td>7</td><td>0</td><td>1,777</td><td>651</td><td>2,428</td></tr></table>	Year	Casualties			Damaged Properties (Million Pesos)		Total Cost of Damage (Million Pesos)	Dead	Injured	Missing	Agriculture	Infrastructure	2009	105	26	5	4,180	2,581	6,761	2010	11	7	0	1,777	651	2,428
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2009	105	26	5	4,180	2,581	6,761																						
2010	11	7	0	1,777	651	2,428																						

<sup>5</sup> There has been no issuance of dam discharge and flood warning to downstream areas of Pantabangan dam in the last three years, because the water levels in the dam has not reached a critical level even during major typhoons.

		2011	13	13	0	1,003	191	1,194	
		2012	8	1	0	449	236	685	
		2013	3	0	16	424	102	526	
		2014	N/A	N/A	N/A	660	248	908	
		2015	10	10	0	297	300	597	
		While damages caused by typhoons in Pangasinan province seem to have been reduced since project commencement up to the time of ex-post evaluation, such data is not available for the entire project-targeted river basins. Nonetheless, 43 out of 55 respondents (78%) of the interviews reported that the NIA/NPC flood warnings in recent flood events and water spilling have saved more lives of people and working animals compared to the situation in 2009 and earlier.							

Source: Terminal Evaluation Report, questionnaire survey to PAGASA, interviews with PAGASA, NPC, NIA and LGUs, and beneficiary survey

Note: Continuous utilization of meteorological and hydrological equipment through appropriate O&M is one of important factors for achieving Overall Goal. Thus, whether the water level equipment have been continuously utilized at the six dams/reservoirs since project completion was checked as supplemental information to verify whether project effects have been maintained to the time of ex-post evaluation.

### 3 Efficiency

Both project cost and project period exceeded the plan (132% and 103%, respectively). This is because the workload for the planned activities increased as a result of updating the performance indicators of the project, and a new activity (inundation analysis in the Pampanga River Basin) was added in response to the request of the counterpart agencies. Therefore, the efficiency of the project is fair.

### 4 Sustainability

#### <Policy Aspect>

“PDP (2011-2016)” mentioned above is still effective at the time of ex-post evaluation, and “PDP (2017-2022)” will be formulated as a successive plan towards the end of 2016. FFWSDO will likely be accorded a high priority as part of the national policy on DRRM. Moreover, “The PAGASA Modernization Act of 2015 (Republic Act No. 10692 in August 2015)” states the needs for enhancing PAGASA’s capability to provide timely and reliable weather forecasting and warning services.

#### <Institutional Aspect>

There has been no major change in the organizational structures of FFWS/FFWSDO along the river basins covered by the project. NPC is responsible for managing FFWSDO in Ambuklao, Binga, San Roque and Angat dams which primarily function as electric power generation. NIA is responsible for managing FFWSDO in Magat and Pantabangan dams which primarily function for irrigation purposes, while PAGASA is responsible for FFWS in the middle and downstream areas of the river basins. The number of staff at the time of ex-post evaluation is 120 in total at PAGASA, 77 in total at NIA<sup>6</sup>, and 22 in total at NPC. In addition, these organizations employ temporary staffs especially during a flood season. The number of staff in these organizations is considered to be sufficient, as they can always hire the services of temporary staff whenever they need them. Moreover, JOMC, which was established in 1989 as the platform entity to enhance the nationwide FFWS/FFWSDO, was attached to the project, and it is still functional at the time of ex-post evaluation. JOMC members include NPC, NIA, the Office of Civil Defense (OCD) of the Department of National Defense (DND), the Metro Manila Development Authority (MMDA), Department of Public Works and Highways - Flood Control Management Office (DPWH-FCMO) and NWRB. JOMC undertakes tasks such as formulation and coordination of plans and programs related to flood forecasting and warning activities for the telemetered river basins, including capacity building of hydrologists of PAGASA, NPC and NIA, flood/community drills and other related activities for a harmonized FFWS/FFWSDO.

#### <Technical Aspect>

At the time of ex-post evaluation, approximately 70% of C/Ps still work for FFWS in PAGASA, NPC and NIA. The skill level of staff in these organizations is sufficient, as in-house trainings and echo-seminars<sup>7</sup> on FFWSDO activities have been continuously conducted in these organizations. These trainings and echo-seminars on dam discharges and warning operations include dam safety program, Rainfall-Run-off Inundation with Graphical User Interface (RRI-GUI), etc. In addition, peer-coaching and/or peer-mentoring are also conducted in these organizations. Manuals prepared under the project such as the Operation Manuals of Dam Inflow and Dam Downstream Forecasting Model for the Agno River Basin, the Angat River Basin, the Upper Pampanga River Basin and the Magat River Basin, and Operation and Maintenance Manual of Equipment for FFWSDO have been continuously utilized. Equipment procured, replaced and/or updated under the project has been maintained in accordance with the manual. While some equipment has problems or is no longer operational, PAGASA conducts timely repair of defective equipment. NPC and NIA are making efforts to immediately replace broken or destroyed equipment using supplemental budgets of their organizations. In the case of NPC, there is an existing Operation and Maintenance Agreement (OMA) with plant operators in each dam. Under the agreement, the repair and maintenance of equipment are shouldered by the plant operator while replacement of defective equipment and/or needed spare parts will be borne by NPC which are already included in NPC’s yearly budget.

#### <Financial Aspect>

According to interviews with PAGASA, NPC and NIA, budget for FFWS/FFWSDO including O&M of equipment has been sufficiently allocated in these organizations, though detailed financial data was not obtained from PAGASA and NIA. Budget deficits are covered through supplemental budgeting system which PAGASA, NIA and NPC can always resort to.

#### <Evaluation Result>

In light of the above, no problem has been observed in terms of the policy, institutional, technical and financial aspects. Therefore, the sustainability of the effectiveness through the project is high.

### 5 Summary of the Evaluation

Through the project activities, target indicators set for the Project Purpose were mostly achieved at the time of project completion. The project effects have been partially maintained while the Overall Goal is partially achieved at the time of ex-post evaluation. As for sustainability, no problem has been observed in terms of the policy, institutional, technical and financial aspects. As for efficiency, both

<sup>6</sup> The number of staff in NIA includes temporary contractual workers.

<sup>7</sup> An echo (or re-echo) seminar refers to a seminar conducted by a participant or participants to a prior particular seminar/workshop to share what were learned from that seminar/workshop with others.

project cost and project period reasonably exceeded the plan, as the project, upon concurrence of JICA, flexibly responded to the request of counterpart agencies to undertake a new activity at mid-term which emerged too important to achieve project objectives (inundation analysis in the Pampanga river basin). Subsequently, the project updated its performance indicators. Considering all of the above points, this project is evaluated to be satisfactory.

### III. Recommendations & Lessons Learned

#### Recommendations for Implementing Agency:

- It is recommended that PAGASA facilitate updating of both the flood forecasting and warning models by including the results of the community drills on “dam break scenarios” and other considerations related to the privatized power component of the dam operations.
- It is also recommended that PAGASA makes follow-up and monitor repairs and replacements of defective water level sensors and rain gauges by NPC and NIA.
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#### Recommendations for JICA:

Regarding the River Cross Section Database for Target River Basins, which was developed under the project and has not been handed over from Japanese experts to PAGASA, JICA should check and clarify the current status of the database and promptly hand this over to PAGASA for their utilization.

#### Lessons learned for JICA:

The indicators set for the Overall Goal of this project are the reduction of the number of victims and the amount of economic losses in the river basins. The basin is comprised by many provinces and there is no single organization that collects river basin-wide data and therefore it is difficult to obtain basin-wide data. When implementing a similar project in the future, it is important to collect baseline data required for indicators of Overall Goal and set appropriate target values at the beginning of a project, to collect actual data against the target values at project completion, and to establish a mechanism in which an implementing agency can collect and maintain records of necessary data even after project completion.



Equipment provided under the project  
(water level telemetry subsystem)



Operation rule used by Magat Dam