

## 40 years of Flood Forecasting and Warning Service in the Philippines: Complementing the structural flood mitigation program of the Philippine government

### The Pampanga River Basin Flood Forecasting and Warning System (1973 to 2013)

Within the sprawling compound of the Diosdado Macapagal Government Center in Barangay Maimpis, City of San Fernando, Pampanga is a relatively small one-storey building beside a 35 meter tower, occupied on a 24/7 shifting operations by 5 persons doing daily hydrological monitoring and forecasting of an imminent flood in one of the major basins in the country. There's nothing (really) remarkable about that building with its regular set of computers and stacks of communication tower cabinets within it, not until you take a closer look inside, chat with the duty personnel, and then consider that this is where flood warnings are being formulated and issued in the form of advisories and bulletins for the Pampanga River Basin and its allied river system. And come to think of it, this activity has been going on close to nearly 40 years now.

The Pampanga River Basin Flood Forecasting & Warning Center (PRBFFWC or PRFFWC) is the pioneer flood forecasting and warning service in the Philippines and has been the foremost center in this field since 1973. It is also one of the major frontline services of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) in terms of flood information & warning activities. Other than mainly providing flood forecasts and warnings to its objective area, which is the Pampanga River Basin (PRB) and the allied basin system of Pasac-Guagua Rivers, it complements the agency in terms of its other activities on community-based programs and public information drives not only within its basin of concern but in other areas around the country as well.



The new PRFFWC center in the City of San Fernando, Pampanga



The operations building of the PRFFWC in CSFP, Pampanga (Inaugurated March 2009)

### FFWS Historical Background

The Pampanga River is one of the 2 major river systems draining the Central Luzon plain (the other one is Agno River), which is oftentimes referred to as the "rice granary of the Philippines". It practically transcends the provincial boundaries of Nueva Ecija, Pampanga, about half of Bulacan and a third of Tarlac, and small portions of about 6 other provinces. The area, unfortunately, suffers considerable flood damage almost every year.

The PRB is a densely populated area with a thriving economy and various development programs are being carried-out continuously. With persistent rapid economic development in the basin the average flood damage is likely to increase correspondingly. In the early 60s, a view of reducing the flood damage with an establishment of a flood forecasting and warning system including structural flood protection measures has been engaging the attention of both the then Weather Bureau (WB) and the Bureau of Public Works (BPW).

The floods of August 1960, July 1962, and May 1966 are several of the destructive floods that affected the then flourishing agricultural area in the Pampanga River Basin. However, a flood in July 1972, which was considered one of the most disastrous in Philippine flood records, affected Central Luzon. It inflicted a total damage of about \$300 million (US) in Central Luzon area particularly in the Pampanga River Basin. Flood control structures were a no match to the level of flooding at that time, being structurally limited only to regular recurring floods and the fact that such structures normally require enormous annual amount of maintenance. That flood opened the eyes of the government authorities and saw the importance and the need for a non-structural measure of mitigating flood loss and damages – a Flood Forecasting and Warning System (FFWS) in the major river basins in the country.

### **The start of FFWS: Circa 70's**

The Government of Japan (GOJ), with a view of promoting technical cooperation between Japan and the Philippines, submitted a proposed detailed report for a flood forecasting project to the latter (Government of the Philippines or GOP) in March 1970 following a survey of the PRB made by a team of Japanese experts in the later months of 1969.

The then WB (now PAGASA) and the BPW (now DPWH) formalized a Memorandum of Agreement for the establishment and operation of the proposed flood forecasting system by early 1971. A flood forecasting center was established in the Weather Bureau in September 1971 in cooperation with the BPW. Trial computation was undertaken by the Center on the basis of the Japanese survey team's report and with the assistance of the Typhoon Committee Secretariat (TCS).

In April 1971, the Diet of Japan approved the appropriations of a sum of US\$ 260,000 for the provision of equipment and training of personnel for the Pampanga river flood forecasting system. The BPW allocated PhP 500,000 for the construction of housing and other facilities that were needed for the installation of the equipment. A second survey team of Telecommunications experts from Japan completed site selection and communication tests that were embodied in a report submitted to the GOP in September 1972. It contained detail design and specifications for the system.

After subsequent exchange of official communication notes between the Governments of Japan and the Philippines, an agreement was reached with Japan Radio Co., Ltd. (JRC) being accredited for the supply and installation of equipment for the flood forecasting system. In May-June 1973, the equipment from Japan was received and at which time a good part of the station housings and other facilities were already completed by the BPW. The JRC engineers carried out the installation works between June to August 1973 with the help and cooperation of the WB, BPW and the TCS. The GOJ also sent three experts, one hydrologist and two telecommunication experts, to supervise in the installation works and to provide technical advice and on-the-job training to the local technicians. Information was also received that additional equipment worth US\$ 200,000 comprising of a vehicle equipped with wireless communication, a motor boat and an electronic table computer would be donated by the GOJ as part of the technical assistance program.

## FFWS Start of Operations

FFWS operations in the Philippines practically started in PRB at around August of 1973 with the first rainfall data received at the FFWS Center at around 10am of August 09, 1973. Only three stations (San Isidro, Sulipan, and San Rafael) at the start reported data; however by the end of the month there were already 6 rainfall and 3 water level stations reporting. By the following month (September), 10 rainfall and 7 water level stations were already reporting. Though most of the stations were still under review and under observation by both Japanese and trained Filipino experts, nonetheless, operational monitoring activities functioned reasonably well in the succeeding years. At that time the normal data transmission was 12-hour interval during dry season and 3-hourly intervals during wet season. However, the system can be made to transmit data for shorter intervals whenever threatened by typhoons or other tropical disturbances.

As a pilot flood forecasting system, the network consisted of 7 combined rainfall and water level stations, 2 rainfall stations, 1 combined repeater and rainfall station, and 1 repeater station strategically located within the PRB. The terminal telemetry station serving as the nerve center of data collection was located at the Flood Forecasting Center in the PAGASA (WB) Central Office, which was situated before in the Asiatrust Building along Quezon Avenue, Quezon City and a monitor station at the BPW Main Office.

The effectiveness of the system was proven during major floods of October 1973, August and November 1974, May 1976, August and October of 1978 and a lot more.

## The Telemetry and Flood Forecasting and Warning System

The principal advantage of the telemetry system over other conventional communication systems is the rapidity of data collection. The stations can operate unmanned and it is possible to collect data from any or all of the stations at any time desired by the control station.

The FFWS in the PRB envisage forecasting of flood levels at vulnerable places in the lower reaches of the river one day, and if possible two days, in advance. It involved the estimation of basin rainfall, runoff computation, estimation of the flood wave propagation by means of flood routing; empirical correlation and computation of various parameters with the help of computers. Results from the operation of the system were kept for continued review so that in the light of experiences gained, improvements can be carried out whenever appropriate, both in the network of reporting stations as well as in the technical procedures.



The old (far left) and new (2009) rainfall and water station at the Candaba area (Pampanga Province) as part of the network of the hydrological monitoring system for the Pampanga River Basin.

## **The ABC FFWS Program**

The effectiveness of FFWS in providing timely flood information and warnings in the PRB has motivated the GOP to recognize the importance of such system and to extend it to three other basins in Luzon, namely: the Agno, Bicol and Cagayan River Basins (ABC).

Following a series of surveys by the Japan International Cooperation Agency (JICA), a continuing exchange of notes between both GOP and GOJ and the confirmation by the Overseas Economic Development Fund (OECF) of Japan concluded the Republic of the Philippines with a loan agreement in January 14, 1978 amounting to ¥ 1,774,000,000 for the establishment of FFWS in the ABC River Basins.

In 1980, the civil works and installation of the equipment and telemetering system for the Bicol River Basin Flood Forecasting and Warning Subsystem were completed. On the other hand, completion of the same works for Agno and Cagayan River Basins were partly delayed due to the passage of Typhoon "Aring" in November 4-5, 1980.

The acceptance test for the Bicol River Basin Telemetering subsystem and the multiplex radio telecommunication for the Naga-Tanay-NFFO (National Flood Forecasting Office) Operation Center link were undertaken in 1981 followed by the acceptance test for the telemetering subsystem of Cagayan River Basin in June of the same year. The Agno River Basin telemetering subsystem was accepted in March 17, 1982.

## **The FFWSDO Program**

In the early morning of October 27, 1978, torrential rains spawned by Typhoon "Kading" affected the province of Bulacan. A great volume of flood water flowed into Angat Dam's reservoir necessitating the release of water therein in order to prevent the dam from collapsing and causing the loss of lives and tremendous damage to livestock and properties. The release, however, caused a massive flood that covered the towns along the Angat River, particularly the town of Norzagaray, caused several deaths and destruction of houses, farms, plants, working animals and other properties of the people residing near the waterway. A number of people were able to save their lives only by climbing trees.

The sad experience from that unfruitful event has led authorities to again recognize the need for a flood forecasting and warning system in major dam sites. To prevent the occurrence of similar disasters, the Flood Forecasting and Warning System for Dam Operation (FFWSDO) project was conceived and finally started in April 1983, one year after signing the memorandum of agreement between the Governments of the Philippines and Japan. Implementation of the project was done in two stages (Phase I and II). Phase I, which was completed in July 1986, was funded under the 10<sup>th</sup> Yen Loan Package from the Japan OECF while Phase II was funded from the proceeds of the 13<sup>th</sup> OECF loan.

Phase I covered the areas downstream of Angat and Pantabangan Dams, from Norzagaray to Plaridel (Bulacan Province) and Rizal to Sta. Rosa (Nueva Ecija Province), respectively. Phase II covered the areas downstream of Magat (in Cagayan River Basin) and the Binga/Ambuklao Dams (in Agno River Basin), from Maris to Naguilian (Isabela Province) and from San Roque to Carmen (Pangasinan Province), respectively.

Apart from real-time telemetering system consisting of the optimum number of rainfall and water level gauging stations (inclusive of reservoir water level gauge and supervisory control stations in the dam offices), the FFWSDO components included fixed warning stations with sirens and speaker enabled voice information messaging system that are situated strategically downstream of these dams. Part components of the FFWSDO Phase II program also included additional network of stations, such as 4 additional rainfall and water level stations for the Pampanga River Basin, and upgrading of its existing facilities.

Phase II of the project included the establishment of the PAGASA Data Information Center (DIC) building, flood forecasting and warning centers, flood forecasting and warning system at dam office, hydrological stations, warning posts, repeater stations and monitoring stations. The project was implemented with the National Power Corporation (NPC) and the National Irrigation Administration (NIA) as coordinating agencies and PAGASA as lead agencies.

The implementation of Phase II contracted the services of NIPPON KOEI, co. Ltd. (NK) and BASIC Technology and Management Corporation as consultants. Services included detailed design of necessary civil works and telecommunication facilities, preparation of warning operation manuals, conduct of training to effect technology transfer and supervision of construction of other related consultancy services. JRC and Tomen Corporation were contracted in the supply, installation, testing and calibration of telemetering and telecommunication equipment, rehabilitation of the existing FFWS and conduct of on-the-job training for said systems of personnel of participating agencies.

The PAGASA DIC was made operational around early 1992 and the PRFFWC and FFWSDO services were then housed in the said building. The weather forecasting services was also housed in the same building to have a close coordinated data and info exchange between hydrological and weather elements to be used not only in the existing FFWS and FFWSDO areas in the Luzon island but in other flood-prone areas in the country.

### **FFWS in 80s, 90s and beyond...**

The PRBFFWS in the 80s and 90s was able to provide flood warnings in the form of bulletins in many such flood events within the basin, among these events include Typhoon "Openg" in September 1989, Typhoon "Kadiang" in September 1994, and the effects of Southwest Monsoon in August 1999. The ABC basins have had their share of timely flood bulletin issuances during the same period in their respective basins.

The advent of decade 2000 registered more serious flood events in the Pampanga and the ABC River Basins as unprecedented inundations battered a lot of these basins during that period. It was a clear manifestation that the threat of climate change and the wanton handling of our natural resources and surroundings have further compounded the floods not only in the PABC River Basin systems but in a lot of areas throughout the country. Among these flood events that affected the Pampanga River Basin included Typhoons "Ditang" and "Edeng" in July 2000, Tropical Depression "Winnie" and Typhoon "Yoyong" in November-December 2004, Typhoon "Pepeng" in October 2009; Typhoon "Pepeng" also affected the Agno River Basin, far worse than the typhoon's effect in PRB; Bicol River Basin by Typhoon "Milenyo" in September 2006.

Early years of 2000, after more than 30 years of operations in the PRFFWC and more than 25 years for ARFFWC, signs of deterioration, obsolescence of equipment, interfered data transmissions and regular

equipment downtimes has practically made flood forecasting and warning operations rather difficult in the PRB as well in the other systems.

In 2003, an upgrading of the present FFWS set-up was approved by the GOJ as per request by the GOP and the project was among the first three projects to be implemented by the JICA in 2008. The project was aimed at improving and expanding the existing monitoring system and telecommunication facilities for a wider coverage of the target area and for fast transmission of observed data. This will ensure issuance of timely and reliable flood info and warnings to the flood-threatened communities. Further, it also addressed the issue of bringing FFWS services to the countryside and closer to the target communities. The project was termed as the “Improvement of Flood Forecasting and Warning System in the Pampanga and Agno River Basins”.

### **Improvement of FFWS in the Pampanga and Agno River Basins**

On March 18, 2009, the upgraded PRBFFWC was inaugurated at its present location, in the Diosdado Macapagal Government Center in Bgy. Maimpis, City of San Fernando, Pampanga province. The project was under Phase I of the improvement of FFWS in the Pampanga and Agno River Basins. The new features of the upgraded system included 5 additional gauging stations, high frequency backbone telecommunication system to address the interference problem, and the transfer of the operations of the PRBFFWC at its new building.

At its new location, the PRFFWC was able to provide timely flood information to its target communities during flood events such as Typhoon “Pepeng” in October 2009, Typhoons “Pedring” and “Quiel” (Sept to October 2011), and lately the enhanced Southwest Monsoon of August 2012. Further, the center was able to build its rapport with various Local Disaster Risk Reduction and Management Councils (LDRRMCs) not only within the basin of concern but also in the regional level (Region 3), as well as in other regions in the country. Various LGU and community level programs were also spearheaded by the center including school-based programs such as the “School Hydrological Information Network” or “SHINE” and other community-based flood mitigation and management programs.

On April 08, 2011, the upgraded system of the ARBFFWC was inaugurated under the Phase II program of the Improvement of FFWS in Pampanga and Agno River Basins. The old center building was rehabilitated into a new 2-storey building and still sits at its present location in DPWH Agno River Flood Control Compound in Bgy. Tumana (Carmen, Rosales, Pangasinan). The project features include the upgraded telemetry observation system, multiplex radio communication system, integrated computer system, data processing and analysis and flood forecasting and warning system.

Phase III of the project “Improvement of FFWS in the Pampanga and Agno River Basins” was focused on the upgrading of FFWSDO in the Dam areas within the Pampanga, Agno and Cagayan River Basins. The program is still on-going with expected project completion on or before year-end 2012.

While there are still many areas within the country that needs an FFWS, particularly systems such as those in the PABC River Basins, other programs such as Community-Based Flood Early Warning Systems (or Local FEWS) are emerging system activities that can address the immediate issues of providing timely flood warnings in a flood-prone community. The PAGASA has been in the forefront in supporting and promoting such programs in many areas within the country.

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