Department of Science and Technology
Philippine Atmospheric, Geophysical and
Astronomical Services Administration
Republic of the Philippines

DATA COLLECTION SURVEY ON SITUATION OF NATIONWIDE FLOOD FORECASTING AND WARNING SYSTEM IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

September 2013

Japan International Cooperation Agency

Nippon Koei., Ltd.

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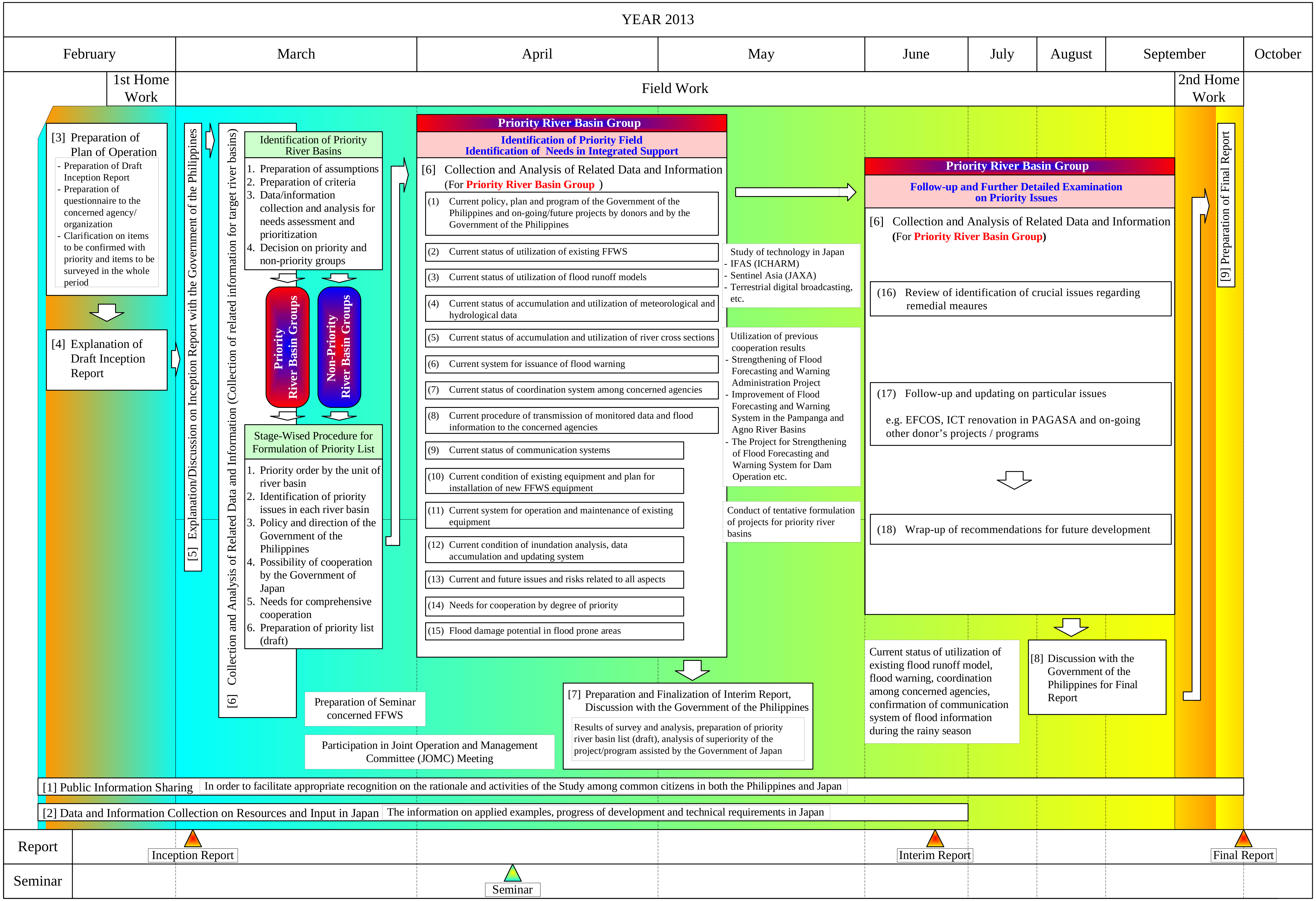
No.	Name of River Basin	Area (km^2)	18 Major River Basin	Existing FFWS/ FFWSDO
1	Cagayan	27,280	✓	✓
2	Agno	5,952	✓	✓
3	Pampanga	10,540	✓	✓
4	Pasig-Laguna de Bay	5,125	✓	✓
5	Bicol	3,771	✓	✓
6	Abulog	3,372	✓	
7	Abra	5,125	✓	
8	Panay	1,843	✓	
9	Jalaur	1,503	✓	
10	Ilog-Hilabangan	1,945	✓	
11	Agusan	10,621	✓	
12	Tagoloan	1,704	✓	
13	Cagayan de Oro	1,521	✓	
14	Agus-Lake Lanao	1,645	✓	
15	Tagum-Libuganon	3,064	✓	
16	Davao	1,623	✓	
17	Mindanao (Cotaboto)	23,169	✓	
18	Buayan-Malungon	1,434	✓	
19	Mandulog	782		

Location of Study Area

Work Flow Chart



要　約

1. 序　文

調査の背景

1.1 ルソン島では、雨季には毎年平均 4～5 回の台風の来襲を受けている。フィリピン国（以下、「比国」という）は、洪水被害の軽減対策の一環として、ルソン島の主要流域であるパンパンガ川、アグノ川、マガット/カガヤン川、ビコール川、パッシグ・マリキナ川の 5 流域（以下、「既設 5 流域」という）を対象とした洪水予警報システムを日本政府の無償・有償資金協力等によって整備してきており、これらの洪水予警報システムは、当該流域での洪水被害の軽減に貢献している。

1.2 比国は、世界で最も自然災害の多い国の一つであり、その代表的な災害は、台風・暴風雨、洪水、火山噴火、地震、干ばつ、自然火災、斜面災害、さらに高波・高潮など多岐にわたる。その中で台風・暴風雨による被害が突出して大きく、毎年、約 20 個の台風が接近ないし発生し、甚大な被害をおよぼしている。今後、気候変動や都市化の促進などの影響も相まって、より深刻化することが懸念されている。

1.3 比国では、被害軽減に資するため、構造物対策とともに非構造物対策の主軸として洪水予測に基づく早期警報や避難情報の発出を目的とした洪水予警報システム（Flood Forecasting and Warning System、以下「FFWS」という）の構築が主要河川で進められてきた。科学技術省天文気象庁（Department of Science and Technology - Philippine Atmospheric, Geophysical and Astronomical Services Administration、以下「PAGASA」という)）が中心となって関連機関と調整しつつ、一貫してシステム全体の運営にあたっている。

1.4 過去 40 年間にわたり我が国が継続的に支援してきた成果は、既設 5 流域では徐々に定着し、成果があがりつつある。一方、通常業務に加えて 18 流域への展開などの 17 プロジェクトが進行中であり、PAGASA 内の業務量は急激に増大している。これらのプロジェクトに PAGASA が対応しきれるか懸念があり、また、FFWS を取り巻く状況が変化していることから、過去のプロジェクト形成調査等の分析や評価内容についても更新する必要性が生じている。つまり、PAGASA をはじめとする関連機関の能力強化ニーズ（政策、組織体制、機材、技術、財務等）を明確に把握し、比国の現状に立って、我が国の洪水予警報分野における先端技術の適用可能性も視野に入れた今後の支援ニーズを見定めることが喫緊の課題となっている。

調査の目的

1.5 洪水予警報施設がすでに設置されている 5 流域について、現状を整理したうえで問題点を抽出し、新規 13 流域については現状及び将来の展開見込みを確認し、並びに、主要流域として組み込まれていない 1 流域については小規模河川における洪水予警報の問題にそれぞれ着目し、能力強化ニーズ（政策、計画、組織体制、機材、技術、財務等）を抽出することを調査目的とする。

調査の対象地域

1.6 本業務の対象地域は、以下の 19 流域であり、その位置を巻頭の位置図に示す。

- すでに洪水予警報が導入されている 5 流域
  - ルソン島：アグノ、ビコール、カガヤン、マリキナ、パンパンガ
- 拡大が見込まれている 13 流域
  - ルソン島：アブラ、アブラグ
  - ビサヤ諸島：パナイ、ハラウール、イログ・ヒラバンガン
  - ミンダナオ島：アグサン、アグス - ラナオ湖、ブアヤン - マルンゴン、カガヤン・デ・オロ、ミンダナオ/コタバト、ダバオ、タゴロアン、タグム - リブガノン
- 近年大規模な水害が発生した 1 流域
  - ミンダナオ島：マンドゥログ（イリガン市）

最終報告書

1.7 2013 年 2 月から 9 月にかけて実施された本邦および現地作業に基づく情報と、修正に関する PAGASA からの要望に基づき、本最終報告書が作成された。12 章から構成されている。

収集したデータと情報

1.8 検討に必要な各分野のデータ・情報を関係者へのインタビュー等を通じ収集した。収集した資料の概要はインベントリシートにして取りまとめた。

2. 作業工程

全体作業スケジュール

2.1 調査期間は 2013 年 3 月から同年 9 月までの約 7 ヵ月間である。この間に、セミナーを 1 回、カガヤン州ツゲガラオ市で開催した（関係機関から計 65 名参加）。

3. 対象流域の概況

流域界と行政区域

3.1 流域界と行政区域の GIS データを収集整理した。流域界は「全国洪水リスク評価及び特定地域洪水軽減計画調査」にて作成された 5 万分の 1 スケールのデータを用いた。行政区域は国立地理資源情報庁（National Mapping and Resources Information Authority、以下「NAMRIA」という）作成の 5 万分の 1 地形図に準じた。

水文・気象

3.2 比国では通常 6 月から雨季が始まり、7 月から 9 月にかけて雨季のピークを迎え、10 月に雨季が終わる。また、降雨特性を考慮して 4 つの気候区分が設定されている。

3.3 比国台風監視域では、平均して年間約 20 個の台風発生・通過が確認されている。比国各地域での台風通過頻度は、ルソン島北部では年間 1 個から 2 個、ルソン島中南部では年間 1 個、ビサヤス諸島では 3 年に 1 個から 1 年に 1 個、ミンダナオ島北部では

30 年に 1 個から 1 年に 1 個、ミンダナオ島南部では 50 年に 1 個から 30 年に 1 個である。

氾濫区域

3.4 検討対象 19 流域の氾濫区域図を収集した。主に全国洪水リスク評価及び特定地域洪水軽減計画調査（Flood Risk Improvement and Management Project、以下「FRIMP」という）および MGB から収集した。

4. 関連するフィ国政府の政策、法規、開発計画等

フィリピン国家開発計画 2011-2016

4.1 「フィリピン国家開発計画 2011-2016」では気候変動とそれによる自然災害への影響は、貧困の拡大と環境の質的低下として関係づけている。自然災害は、公共インフラに物理的な被害を及ぼし、人命と健康へ直接的な危害を加え、特に貧困層や社会的弱者の生計を破壊し、苦労して蓄積した個人資産を価値のないものにしてしまう。2005 年の世銀の調査報告書でも伝えているように、災害は、社会経済の開発を阻害してきた。比国では毎年平均約 150 億ペソ、あるいは国民総生産の約 0.5%以上を直接的被害で失っている。間接的被害や二次的な災害のインパクトはこの金額をはるかに上回る。

4.2 このような災害の兆候や極限事象の発生に鑑みて、「フィリピン国災害リスク軽減管理評議会法」（または「共和国法 10121 号」）が制定された。国家災害リスク軽減管理評議会（NDRRMC）には、自然災害や人的災害に対し多様な災害に対する統合的な管理手法を用い国家災害リスク軽減フレームワークを策定する任務が課せられている。洪水予警報システムは、コミュニティの災害に対する強靭性を強化し災害への準備や対応能力を強化するための重要な役割を担っている。

4.3 この行動指針の実行を促すため、被災したコミュニティや地域での援助、救済、復興の目的で一定の金額を特別災害準備基金（約 50 億ペソ）として計上し、災害発生前の活動資金としての使用も認めている。一方、「フィリピン国災害リスク軽減管理評議会法」第 22 節でも、年間の災害準備基金の活用について、一般的に、より広い範囲の支援活動への適用を認めている。

共和国法 101211 号

4.4 「フィリピン国災害リスク軽減管理評議会法、2010 年」または「共和国法 10121 号」は 2010 年 5 月 27 日に上院で承認された。この狙いは、災害による負のインパクトや災害発生の可能性を、行政的な指示や組織・運営上の技術、戦略・政策の実行などを駆使したシステマティックな手段により軽減することにある。

4.5 この記載規定を円滑に実行に移すため、これまでの地域災害基金は、地域災害リスク軽減管理基金として変更された。災害軽減のための活動を支援するために、推定収入の 5%を下らない資金をこの名目で計上する必要がある。この予算は、地域の開発予算に統合される。国家災害リスク軽減管理基金が、人材教育や機材の調達、一般支出等の災害対応準備資金として利用可能となった。

4.6 尚、地域災害リスク軽減管理基金の 30%は緊急対応または救助・復興プログラムの資金として割り当てられ、残りの 70%が他の災害管理に関する活動に利用される。域災害リスク軽減管理基金は、地域災害リスク軽減管理計画の実施のために活用される。

水資源セクター開発計画に向けた国家水資源管理委員会（案）の設置

4.7 より効果的かつ効率的な水資源管理に関する要請にこたえるため（2011 年に）「フィリピン水資源セクター開発計画」が策定された。その中で、PD424（1974 年制定）と PD1067（1976 年制定）の関連条項に従い「国家水資源管理委員会」の設立が提案されている。

4.8 この「国家水資源管理委員会」は、多様な競合する水利用目的を調整し、水資源を管理、保全するための国家の最高機関になるものと考えられる。本管理委員会は現行の国家水資源評議会（NWRB）とその他の関連機関の水資源に関連する機能・部局を統合し、設立される予定である。また、本管理委員会は大統領を首長とした組織として、利害調整支援委員会と日々の運営に責任を持つ執行機関が組織される見込みである。

4.9 国家経済開発庁（NEDA）と公共事業道路省（DPWH）が、政府のインフラ委員会の副議長として、先頭となり本管理委員会の運営計画や組織調整の準備を進めている。2011 年 10 月に発布された大統領令 62 号に従い、DPWH が本管理委員会に関する実施細則を作成し提出する機関として任命された。

4.10 この管理委員会に関する実施細則は、2013 年 9 月現在では承認されていない。依然として NWRMC は設立されていないが PAGASA は引き続き洪水予警報を担当している。

対フィリピン国別評価報告書（「国連国際防災戦略事務局」作成）

4.11 国連国家防災戦略事務局（UNISDR）は、2012 年 4 月に、国別評価報告書を作成した。ここでは、国家の気象・水文情報サービス機関としての PAGASA は、「より正確で、時機を得た、役に立つ予報や情報を発出する必要性があり改善に取り組んでいる」、としている。この要請にこたえるため、改善点として 5 点を挙げている。つまり、(1) 気象・水文事象観測のための十分なネットワーク、(2) 情報転送及び予測や情報共有のための信頼性の高い通信システム、(3) 数値情報・データの高速演算システム、(4) 職員の十分な訓練、(5) 天気・気象情報のユーザー中心のアプローチ、である。

4.12 この報告書は、近年の PAGASA の運営状況に照らし以下の乖離とニーズを指摘している。

(1) データ成果
- 早急なる過去の気象データの照合・整理
- 気象予測に関するデータ管理システム改善
- 遠隔地の観測所の気象観測機器の交換および調整
- 信頼性の高い低コストの観測データの転送システム

(2) リスクアセスメント支援のためのハザード分析
- 被害軽減とリスクアセスメント分野の専門家増員
- 気象予報のための応用ツールの充実

(3) 予報と警報
- 高機能の数値天気情報システムの配置と運用
- レーダー・衛星情報の同化とリモートセンシングプロダクトの発展
- 気象モデル作成分野における人材開発
- 氾濫域における水深までを示した洪水予報
- より進んだ水文量の予測
- 様々なセクターのためのきめの細かな予報

4.13 上記、国別評価報告書の指摘を待つまでもなく、PAGASA 水文気象部（Hydrometeorology Division、以下「HMD」という）の 4 つのすべてのセクションで職員不足が深刻化しており、日常業務をこなすだけでも大きなリスクが介在している。特に、計 17 のドナーによるプロジェクト/調査が HMD のもとで同時進行中である。この HMD の組織強化と職員の能力強化は PAGASA における喫緊の課題の一つである。

災害リスク軽減に関するミンダナオ宣言

4.14 台風センドンにより甚大な被害を受けた、東ミサミス州カガヤン・デ・オロ市で、2011 年 2 月 18 日-19 日、災害リスク及び土砂災害リスク軽減に関するミンダナオ・サミットが開催された。

4.15 このサミットを通じて、"Mindanao Declaration on Disaster Risk Reduction Priorities"が採択された。

4.16 この Declaration には以下の提言が示された。

(1) 被災可能性の高い地域に十分な安全性を備えた避難所を建設すること。

(2) 緊急備品を住民に配布し、危険地域からの住民移転を促し、災害訓練を定期的に実施すること。

(3) 承認が遅れている法案を早期に可決し、災害被害軽減と気候変動に関する政府内協力を推進すること。

マニラ首都圏および周辺地域洪水管理マスタープラン調査

4.17 2009 年 9 月、台風オンドイによりマニラ首都圏は大規模な洪水被害に見舞われた。これをうけ、持続的かつ効果的な洪水管理方策を立案するためマスタープラン調査が世界銀行により実施された。

4.18 PAGASA に関連する施策として次の 4 施策が提案された。

(1) Effective Flood Control Operation System (EFCOS)の改修

(2) マニラ首都圏および周辺地域への雨量計・水位計の追加と降雨レーダーの配備

(3) コミュニティ洪水リスク管理の強化

(4) 災害リスク管理のための情報管理システムの改善（LGU と関連省庁間の通信手段の改善と GIS の活用）

4.19 降雨レーダー配備について詳細な説明は記載されてないが、ラメサダムとラグナ湖中央に位置するタリム島への配備を提案していると推定される。PAGASA は同提案に基づき、タリム島への X-band MP レーダー配備を希望している。

5. 日本国政府の開発・援助方針等

対フィリピン国別援助計画（**2008** 年 **6** 月）

5.1 我が国は 2000 年に初めての「対フィリピン国別援助計画」を策定した。その後の比国における経済情勢の変化、中期経済開発計画（MTPDP）の発表等、新たな国別援助計画が必要であるとの判断から、同計画の改定が決定された。

5.2 対比国援助を行う重要性としては、以下が挙げられる。
- (1) 比国は、海上交通路の要衝に位置し、地政学上及び地域安全保障上重要な国であること、
- (2) 比国は、自由民主主義、人権、市場経済等、我が国と価値観を同じくし、対東南アジア外交における重要なパートナーであること、
- (3) 我が国と比国は長年密接な経済関係にあること（2006 年 9 月、日比経済連携協定に署名）

5.3 第 1 回目の国別援助計画の見直しの過程で、7 つの課題と教訓が抽出された。その中で、この 2008 年の援助計画では、政策支援型、課題志向型援助の重視が明確に打ち出された。比国側において援助効果が維持されることを確保するために、政策支援型の支援をより重視する。また、一定の課題に対し、あらゆるスキームの活用やセクター横断的取り組みによる集中的支援が必要と指摘している。

5.4 重点開発課題として以下の点が取り上げられた。
- (1) 雇用機会の創出に向けた持続的経済成長
- (2) 貧困層の自立支援と生活環境改善
- (3) ミンダンナオにおける平和と安定

5.5 洪水防御や防災管理に関しては、上記項目(2)のもと基礎的社会サービス（自然災害に対する人命の保護）に関連付けてその方向性と重要性が指摘されている。さらに、この援助計画の中では、ミンダナオ島全体のミンダナオの開発に特別な注意が払われている。イスラム教徒ミンダナオ自治地域（ARMM）への支援を重視しつつも、モロ・イスラム解放戦線（MILF）元紛争地域を含め、ARMM 以外の地域に対しても継続的な協力を行い、ミンダナオ島全体の社会経済状況改善を目指す、としている。

対フィリピン共和国国別援助方針（**2012** 年 **4** 月）

5.6 基本的な方針は、「対フィリピン国別援助計画（2008 年 6 月）」の精神を引き継いでいる。新しい援助方針では、両国には密接な経済関係を有するとともに広範な人的交流の基盤が存在し、「戦略的パートナーシップ」の関係に発展していることが確認されたと述べている。

5.7 比国の一人当たり国民総所得（GNI）は 2010 年時点で 2,050 ドルであり、初等教育や母子健康以外の分野では、今後中進国入りを目指す段階に来ている。我が国は、長年トップドナーとして比国への援助を継続してきており、同国における日本のプレゼンス、他国間の協力、民間レベルでの良好な関係など、これまで蓄積してきた外交的資産のさらなる発展を目指している。

5.8 援助の基本方針は、「戦略的パートナーシップ」をさらに強化するため、「フィリピン開発計画 2011-2016」が目標としている、「包摂的成長」の実現に向けて経済協力を実施する、ことと記載している。

5.9 重点分野（中目標）として以下の 3 点を掲げている。

(1) 投資促進を通じた持続的経済成長

(2) 脆弱性の克服と生活・生産基盤の安定

(3) ミンダンナオにおける平和と開発

5.10 洪水予警報システムの整備に関しては、上記項目(2)に関連する。項目(2)のもとで、無償/有償資金協力、技術協力、個別専門家、草の根無償、草の根技協等の様々なスキームによる合計 19 件のプロジェクト/プログラムが提案され、そのうち 18 件が実施済みまたは実施中、残る 1 件は来年度実施予定である。

5.11 2008 年、2012 年の双方の国別援助方針で、二国間協力の基本方針に変更は見られない。アキノ政権のもと、安定した政治運営と堅調な国家経済の追い風を受け、ミンダナオ島の開発が加速されることが期待されている。現在までのところ、急激な変化や新しい阻害要因は特定できない。しかし、ミンダナオ島の対象流域における洪水予警報システムの整備には、計画から維持管理段階まで一貫した安全上の対策が非常に重要となる。

防災分野プログラム形成調査（**2008** 年 **3** 月）

5.12 日本政府は、「フィリピン中期開発計画 2004-2010」に基づき、「対フィリピン国別援助計画（2008 年 6 月）」を策定した。その中で、「防災管理プログラム」は重要課題の一つである「貧困層の自立支援と生活環境改善」の中に位置づけられる。比国では、将来の気候変動の影響を考慮すると、災害リスク軽減の重要性は非常に高い。

5.13 本プログラム形成調査は、2007 年 11 月から 2008 年 3 月の間に現地調査が実施されその後、報告書がまとめられた。政府開発援助（ODA）の基本方針である「選択と集中」に則り、策定された「対フィリピン国別援助計画（2008 年 6 月）」に基づき、課題志向型アプローチによりプログラムが策定された。

5.14 近年の自然災害の特徴をレビューした上で、防災管理分野で様々なスキームによる合計 8 個のプロジェクト/プログラムが取りまとめられた。2013 年 4 月現在、このうち合計 5 案件が進行中である。本形成調査では、河川情報サブプログラムの中で、洪水予警報・レーダー雨量計の整備が提案されている。これを受け、その後「ダム放流に関する洪水予警報能力強化プロジェクト」（以下、「ダム技プロ」という）が実施され、2012 年 12 月に完了した。しかし、洪水予警報システムの全国展開や、プロジェクト NOAH[1]に関しては、この時点で予見することは困難であった。

[1] Project of Nationwide Operational Assessment of Hazards： アキノ大統領の指示で、災害被害軽減を目的とし、2012 年 7 月に開始された計 8 項目（600 ヶ所の雨量観測計、400 ヶ所の水位観測計設置など）からなる比国プロジェクトである。科学技術省の先端技術研究所（Advanced Science and Technology Institute）とフィリピン大学が中心となり、プロジェクトを実施している。

全国洪水リスク評価及び特定地域洪水軽減計画調査（FRIMP）

5.15 本計画調査は、合計 1,164 流域を 2 回の選別を経て、26 件の外国資金によるプロジェクトと 30 件の内国資金によるプロジェクトが特定された。2008 年の最終報告書によれば、2 次選定を通じて 6 流域が選ばれ、初期的マスタープランが策定された。この計画調査では想定洪水被害算定のため、NAMRIA の 5 万分の 1 地形図を用いて、概略の氾濫解析が行われた。その結果としての流域ごとの想定氾濫域図は最終報告書に掲載されている。

6. 既設 FFWS/ FFWSDO の運用状況

比国における既設 FFWS/ FFWSDO の概要

6.1 1973 年、パンパンガ川流域において、国連台風委員会の手により比国で最初の洪水予警報システムが導入された。それ以来、主として JICA や日本政府による支援のもと開発が進められ、現在では、カガヤン川、アグノ川、パッシグ・マリキナ川（ラグナ・デ・ベイ）、ビコール川各流域に予警報システムが設置されている。

6.2 洪水予警報システムは基本的に河川氾濫を対象とした FFWS および、ダム放流のための FFWS（FFWSDO）に分けられる。また、マニラ首都圏の洪水防御に重要な役割を果たしている EFCOS はマニラ首都圏開発庁（Metropolitan Manila Development Authority、以下「MMDA」という）の管理下にある。この EFCOS のデータは、今雨期から PAGASA の Weather and Flood Forecasting Center (WFFC)でもリアルタイムでデータが見られるようになった。一方、FFWSDO は、カガヤン/マガット、アグノ、パンパンガ川上流、アンガット、カリラヤ FFWSDO が稼働している。

6.3 運用管理上は、FFWS は PAGASA が、FFWSDO はダム管理者（国家かんがい局（NIA）、国家電力公社（NPC））が責任を持つが、FFWSDO は PAGASA がダム管理者と密に連携しながら運用している。

6.4 一方、その他の 14 流域（13 主要流域＋マンドゥログ川流域）は、既設 5 流域とはかなり状況が異なっており、観測所の数が非常に少ない。従って、求められる精度で、遅滞なく洪水警報を発出することが困難な状況である。

PAGASA の組織状況と HMD の業務管掌

6.5 本調査のカウンターパートである PAGASA HMD が所管する業務は、洪水に関するデータ収集・分析、データベースの管理、洪水予測、洪水情報の発信、テレメータ機器の維持管理、など全部で 11 のカテゴリーに分割される。

PAGASA HMD による洪水予警報業務

6.6 PAGASA は全 8 部局から構成され、HMD はその一つである。HMD は、既設 5 流域のシステムの管理責任を有する。一方、各流域で洪水の観測と観測所の維持管理を主たる業務とするリバーセンターは PAGASA 地域サービス部（PRSD）に所属する。

6.7 各流域において、適切な洪水情報を発信するためには、HMD と PRSD の緊密な連携が不可欠である。HMD は、洪水予警報課（FFWS）、データ管理課（HMDAS）、テレ

メータ課（HMTS）の三課で構成される。2013 年 9 月現在、職員数は、HMD が 49 名、リバーセンターが 24 名（4 ヶ所の合計）である。

6.8 HMD による洪水予警報に係る業務は、PAGASA WFFC のメインオペレーションセンター（MOC）と各リバーセンターにて実施されている。各部署の役割は次のとおりである。

- HMD 部長
  - 水文に係る計画、プログラム、施策に従い洪水予警報業務の編成、実施と見直しを行う
  - 洪水予警報業務全般に関して、各リバーセンターや洪水予警報業務を担う関連機関との調整を行う
  - 洪水予警報業務を担う関連機関である NIA、NPC、DPWH、市民防衛局（OCD）や FFWSDO と EFOCS との調整を行う
  - 地方行政と国際機関との調整・協力を行う
- FFWS 課
  - 水文情報・洪水情報の発信準備のために比国の河川の気象・水文状況の監視を行う
  - ダム放流予警報を担っている関連機関の NIA、NPC との協力と MMDA やその他関連機関との協力を行う
  - 洪水予警報に係る理論、手順、技術を向上させること
  - 国家レベルで洪水やその他の事案に関しての啓蒙活動を実施する
- HMDAS 課
  - 水理・水文予測、氾濫・洪水予測モデル、ハザードマップやその他アプリケーションのための基本的な水理・水文データの収集と処理を行う
  - 水理・水文アプリケーションの理論、手順、技術を向上させることと HMD のデータベース管理システムの維持管理をする
  - 非リアルタイムデータの収集と 1 次処理を行う
  - 気象・水文ネットワークのデータ出力に関して、PRSD と協力する
- HMTS 課
  - 雨量・水位観測装置及びテレメータ装置、通信ネットワークの運営と維持管理の状況を監視する
  - テレメータ装置、マイクロ無線機材、ネットワーク通信システムの運用・維持管理に係る理論、手順、技術を向上させる
  - FFWSDO に関わる無線通信システム構築の際には NIA 及び NPC と協力する
- リバーセンター（パンパンガ川、アグノ川、ビコール川、カガヤン川流域）
  - FFWS 課と共同で水文・洪水情報の発信準備のために対象流域の気象・水文状況の監視を行い、合わせてダム放流予警報（ビコール川は除く）との運営を行う
  - 水理・水文調査、観測データの 1 次処理、FFWS 課と HMDAS 部署との共同による洪水後の流域実情調査を実施する
  - HMTS 課と共同作業にて雨量・水位観測所及びテレメータ機器を維持管理する

- 地方レベルにおいて、洪水と関連事象に関する一般への情報を公開する
- 洪水避難などに関して地方機関と協力する

➢ MOC
- 各リバーセンターの気象・水文状況を監督、助言、調整を行う
- 地方におけるコミュニティ早期警報システムに対して技術的支援を与える
- リバーセンターの有無に関係なく一般洪水助言を作成し、発令する
- PAGASA の所有するデータと情報（気象情報、予警報など）をリバーセンター、NIA、NPC、DPWH、MMDA、OCD へ伝達する
- リバーセンターや DPWH やその他関連する会社・機関・マスメディアなどが作成した資料・情報を参考に収集する
- マスメディアやその他関連機関への洪水状況その他を報告・説明する
- MOC は FFWS 課と HTMS 課から構成され、その活動全体は FFWS 課チーフ（チーフ不在の場合は Senior Flood Forecaster が代理を務める）により監督される。

ドナーの支援による実施中のプロジェクト

6.9 現在、HMD が関与するドナーによる進行中のプロジェクト/プログラム数は 17 にのぼる。HMD は職員の技術教育に積極的に取り組んでいるが、およそ 50 名足らずの職員でそのすべてを運営しており、要員の不足は顕著である。

7. 観測、情報管理、解析に関する現況および解決すべき課題

FFWS における気象・水文観測

7.1 水文・気象観測は FFWS の基本的機能の一つである。現在 PAGASA が FFWS の対象としている気象スケールは台風やモンスーンのような大規模気象擾乱である。水位観測局は対象河川の水位を計測し、計測水位を基に河川周辺の氾濫域へ警報が発出される。雨量観測局では対象地域の雨量を計測し、計測された雨量強度は比較的広い範囲への警報発出に用いられている。

気象・水文観測の現状

7.2 比国での気象・水文観測は PAGASA、NIA、NPC、MMDA、先端科学技術研究所（ASTI）により実施されている。検討対象 19 流域における調査時点での水文・気象観測所リスト、位置図を作成した。

7.3 自動雨量観測所数は ASTI 所管が 101 箇所、MMDA 所管が 7 箇所、PAGASA 水文気象部所管が 74 箇所、PAGASA 地方部所管が 77 箇所、合計 259 箇所である。自動水位観測所数は ASTI 所管が 66 箇所、MMDA 所管が 10 箇所、PAGASA HMD 所管が 45 箇所、合計 121 箇所である。自動気象観測所数は ASTI 所管が 82 箇所、PAGASA 地方部所管が 75 箇所、合計 157 箇所である。

7.4 自動雨量観測所の配置密度は、ルソン地方で 10,000km^2 当たり 13.21 箇所、ビサヤス地方、ミンダナオ地方でそれぞれルソン地方の 40%、35%の観測所密度となっている。自動水位観測所の配置密度は、ルソン地方で 10,000km^2 当たり 7.64 箇所、ビサヤス地方、ミンダナオ地方でそれぞれルソン地方の 15%、10%の観測所密度となっている。

7.5 比国政府や援助機関により、水文・気象観測網が拡充されつつある。ビコールプロジェクト、Norad プロジェクト、Resilience プロジェクト、ADB/JAXA プロジェクト、Project Climate Twin Phoenix、国連世界食糧計画等のプロジェクトにおいて水文・気象観測装置の導入が進行中または予定されている。

7.6 NOAH プロジェクトの Hydromet コンポーネントでは、雨量計と水位計を合計 1,000 基、2013 年末までに導入する目標が掲げられている。2013 年 1 月時点で合計 250 基の雨量計と水位計が設置されている。

7.7 潮位観測は NAMRIA により実施されている。NAMRIA の観測所が存在しない洪水予警報対象流域では河口部に水位計が設置されている。

水文・気象観測の課題

7.8 降雨は地上雨量計だけでなく、降雨レーダー、気象衛星によっても観測されている。持続可能な観測システムとするためには、ターゲットとする気象スケールや流域特性を考慮し、整備目標とする地上雨量計密度を設定しなければならない。水位計測については、警報発出の対象河川を設定し、適切な箇所に水位計を設置しなければならない。

7.9 雨量・水位計の設置に当たっては関係者間での調整が十分ではなく、同じ場所に複数の観測機器が設置される事態が生じている。PAGASA によれば同じ場所に設置されていてもそれぞれ異なる値を観測しているとのことであるため、各観測所の信頼度が明らかにされなければならない。また、機器の重複は設置・維持管理費用や職員の負担を増加させることから、設置計画の改善が必要である。

7.10 PAGASA 地方部所管の自動雨量観測所、自動気象観測所は 2008 年から稼働している。これらの観測所の観測結果については現在 PAGASA で精度を確認中である。今後、これらの観測所を洪水予警報に取り入れる場合、観測精度を明らかにする必要がある。

7.11 PAGASA によれば自動雨量観測所、自動水位観測所、自動気象観測所のセンサーのうち精度の低いものがある。例えば超音波式など非接触式水位計の精度に疑義を持っており、PAGASA は水圧式水位計の導入を優先的に考えている。しかし、単純に精度の高いセンサーを導入すればよいというものではなく、機器の特性を考慮した整理がなされなければならない。超音波式水位計は設置が簡単であるため、観測箇所数の増加という意味では大きな貢献を果たしてきているはずである。ただし、注意しなければならないことは、全ての観測所を同列に扱うのではなく、観測精度を考慮して観測所の階級分けを行い、観測結果を用いる際に注意するということである。

7.12 潮位観測結果は洪水観測時に PAGASA・NAMRIA 間で共有されなければならない。

FFWS におけるデータマネジメント

7.13 FFWS の導入により、取り扱うデータ量が飛躍的に増加する。例えば雨量であれば、日雨量から、時間雨量や 10 分雨量等となる。データマネジメントに関して、FFWS 導入による大きな相違点は、雨量や水位が自動で計測されるが機器が正常に機能しているかチェックする必要が生じること、計測データを自動的にリバーセンターや

HMD に転送する必要が生じること、計測データをデータベースに自動的に蓄積する必要が生じること、蓄積したデータを効率的に品質管理する必要が生じることである。

データマネジメントの現状

7.14 洪水予警報システムでの観測結果は手作業でエクセルシートへの入力が行われている。また、いくつかのリバーセンターではデータの品質管理が行われている。

データマネジメントの課題

7.15 今後、洪水予警報システムが既設 5 流域以外の流域へ拡張される予定である。これに伴い、扱うデータ量の増加が予測されることから、データ処理の自動化が望まれる。

7.16 現行の洪水予警報システムはそれぞれ独立に導入・運用されているため、これらのデータを 1 か所に集め、統合する試みが必要である。

7.17 雨量や水位の自動観測結果は膨大な量であり、現状の PAGASA の能力を考慮すれば全てのデータの品質管理を実施することは現実的でない。品質管理の戦略が策定されるべきである。

FFWS における測量調査

7.18 水位計零点の標高調査は、水位計測結果を河道横断や地盤高と比較するために実施される。河道横断測量は河道流下能力を算定すること等を目的に実施される。流量観測は H-Q 式を作成し、流量を推定するために実施される。

測量調査の現状

7.19 FFWS 及び FFWSDO の水位計の零点標高は測量調査が実施され、標高値が洪水予警報運用マニュアルに記載されている。NOAH の観測所については調査が実施されていない。

7.20 河川横断測量は DPWH、NIA、PAGASA 等の機関により実施されている。

7.21 流量観測は定期的に実施するよう洪水予警報運用マニュアルに記載されているが、予算・人員の制約から実施機会は限られている。

測量調査の課題

7.22 パッシグ・マリキナ川流域以外の洪水予警報システムでは、水位観測結果が観測数値のみ表示されている。水位が河川横断形の上に図示されれば、洪水の切迫度が分かりやすくなるので改善する必要がある。

7.23 ダム技プロ（2012 年）において、信頼度の低いベンチマークを用いることによる河川横断測量の精度低下が指摘されている。測量業者の能力をチェックする仕組みの整備や NAMRIA との情報共有の強化が必要である。

7.24 比国では河川管理者がいないため、さまざまな機関で河川横断測量が実施されている。効率的に測量成果を活用するため、関係機関での適切な調整が必要である。河川横断測量データは、主に紙形式での保存がなされており、デジタル化されていない。河道

横断測量の成果をデジタル化し、インベントリー情報を関係機関で共有する必要がある。

7.25 河道形状は堆砂や洗掘により変化するものである。観測された水位や H-Q 式により推定された流量は河道形状変化の影響を受けるということに注意し、洪水予警報システムの運用や洪水予測モデルの構築を行う必要がある。また、定期的に河道横断測量を実施する必要がある。

7.26 流量観測は H-Q 式を設定するために実施され、H-Q 式からは河川流量が推定される。河川流量は特にダムなどの流況調整施設の運用・計画に重要であるから、施設の管理者や建設者が主体となって実施すべきである。また、予算・人員の制約を考えると観測地点は適切に選定しなければならない。

FFWS における洪水予測モデル

7.27 洪水予測モデルは予測精度の向上や、長時間のリードタイムの確保に貢献する。

洪水予測モデルの現状

7.28 比国において、整備済み及び整備途上の FFWS 関連の洪水予測モデルについて現状を整理した。

- ダム技プロ（2012 年）ではダム放流警報の運用能力強化を目的として、カガヤン川、アグノ川、パンパンガ川で貯留関数法により洪水流出モデルを構築した。
- ICHARM ではカガヤン川、パンパンガ川に洪水流出モデル IFAS を適用した。実運用には至っていないが今後改良を進める予定である。
- Risk Assessment Project (RAP)では、パッシグ・マリキナ川を対象に HEC-HMS と HEC-RAS 及び LIDAR データを用いて洪水流出、氾濫解析モデルを構築した。
- 現在実施中の NOAH DREAM プロジェクトでは LIDAR 測量、HEC-HMS と HEC-RAS による洪水流出・氾濫解析を実施している。パッシグ・マリキナ川、カガヤン・デ・オロ川、マンドゥログ川での洪水ハザードマップが WEB サイト上で公開されている。
- NOAH FloodNET プロジェクトでは、NOAH DREAM プロジェクトで構築した洪水流出・氾濫解析モデルを用いて洪水予測を実施している。

洪水予測モデルの課題

7.29 洪水流出モデルが構築され、実運用されている流域はカガヤン川、アグノ川、パンパンガ川の 3 流域のみである。他の流域についても早急にモデルを構築し、運用するべきである。ただし、予算・人員の制約を考慮し、段階的に整備していく必要がある。

7.30 ダム技プロ（2012 年）で構築されたモデルは、ダム放流警報範囲のみを対象としている。今後、洪水予警報の対象地域全体をカバーするよう拡張する必要がある。

7.31 上記の洪水流出モデルは限られたデータにより作成されたものである。今後、観測データを蓄積して更なるキャリブレーションを実施する必要がある。

FFWS における氾濫解析

7.32 氾濫解析は氾濫区域を特定し、FFWS の対象範囲を設定する際に用いられる。また、氾濫予測を実施するために用いられる。

氾濫解析の現状

7.33 比国において、整備済み及び整備途上の FFWS 関連のはん濫解析について現状を整理した。

- READY プロジェクト、MGB では地形解析によって氾濫区域図が作成されている。
- JICA-FRIMP（カガヤン・デ・オロ川協力準備調査、全国洪水リスク評価及び特定地域洪水軽減計画調査）、NOAH では降雨流出解析および氾濫解析により氾濫区域図が作成されている。
- Dartmouth Flood Observatory (DFO)ではリモートセンシングにより実際の氾濫域を特定している。センチネルアジアではリモートセンシングのトレーニングを実施している。
- ダム技プロ（2012 年）では MIKE FLOOD を用いて、PAGASA のトレーニングを実施した。トレーニングでは、パンパンガ川の洪水メカニズムを解析した。
- NOHA プロジェクトでは氾濫予測に取り組んでいる。

氾濫解析の課題

7.34 氾濫現象に関係する機関は数多くあるので、効率的な解析の実施、効果的な成果の活用のために関係機関での調整が必要である。また、氾濫予測は避難の役に立つが、多大な労力がかかるので段階的に整備していく必要がある。

7.35 氾濫解析の精度向上のためには、大縮尺地形図の作成や LIDAR 測量の実施を進めていくべきである。

7.36 リモートセンシングによる氾濫の監視は特に観測機器が充実していない地域において氾濫状況の把握に役立つ。PAGASA や PHIVOLCS スタッフへのトレーニングを継続し、洪水監視能力の向上を図るべきである。

FFWS における洪水後調査

7.37 洪水後調査は推定された洪水の状況と現実の状況の差を把握するために実施され、洪水予警報の運用改善に用いられる。

洪水後調査の現状

7.38 PAGASA の Flood Operation Manual には、洪水後調査の責任部署と調査実施時期が記載されているが、具体的な調査項目についての記載はない。

7.39 2011 年 9 月の台風 Pedring と Quiel の後、パンパンガリバーセンターでは洪水レポートとして、台風のルート、雨量・水位記録、等雨量線図等をまとめ関係機関に配付した。

7.40 MMDA ではロザリオ堰の運用後、洪水レポートを取りまとめている。レポートには雨量・水位記録、ロザリオ堰の操作記録が記載されている。

7.41　主要洪水時の被害データは州レベルで取りまとめられ、OCD に送付される。

7.42　ブラカン州とパンパンガ州において、日本工営株式会社と地元 NGO の一つである People's Disaster Risk Reduction Network Inc.が共同で洪水実態調査を実施した。局所的な洪水メカニズムの把握、洪水に対して脆弱な地域の社会経済状況の把握を目的として実施された。

洪水後調査の課題

7.43　Flood Operation Manual には洪水後調査の活動内容について具体例が記載されるべきである。

7.44　パンパンガリバーセンターでの活動は継続されるべきであるし、他流域にも展開していくべきである。

7.45　洪水メカニズムの把握を目的として、PAGASA と地元自治体のさらなる協力関係が構築されるべきである。

7.46　PAGASA で現在実施している活動は、観測データを要約し、関係機関に配付しているにすぎない。観測と実際の差を把握する活動が必要である。

8. 洪水情報と協力体制に関する現況および解決すべき課題

洪水情報・警報発出の現状

8.1　パンパンガ川、アグノ川、ビコール川、カガヤン川各流域の洪水予警報システムの運用マニュアルは、「河川流域のための洪水予警報プロジェクト」（2005 年）に作成された。その後、この運用マニュアルは、主に 2005 年以降 PAGASA により修正された箇所を統合し、ダム技プロ（2012 年）のもとで更新された。

8.2　現在、PAGASA HMD からプロジェクト NOAH のサーバーには直接アクセスできない。そのため、HMD 職員によると、現時点ではウェブ上に掲載されたデータ（画面上の数値データ）を限定的に洪水時の情報発出に参照するにとどまっている。

8.3　洪水情報発信の体制は、既設の 3 流域（パンパンガ川、アグノ川、カガヤン川）とも、流域全体に関する洪水情報は PAGASA が、ダム放流影響区間に関する洪水情報（ダム放流量）はダム運営責任機関（NIA または NPC）が責任を担っている。

8.4　PAGASA から発出される洪水情報は、各ダム事務所を通じて、各警報局からテープで流すことが規定されているが、ダム放流警報と内容的に重複することがあり、ダム技プロ（2012 年）の中で改善が図られ、運用に移されている。また、警報基準水位（特に避難開始水位）に関しては、これまで水位観測地点の河道横断面積の比率で決められていたものを、避難に必要な時間を考慮し個々に設定された。

洪水情報・警報発出の課題

8.5　2012 年、パンパンガ・アグノ・カガヤン川の FFWSDO 対象区間において警報基準水位の見直しが行われた。今後、流域全体を対象として水位観測所の基準水位見直しを実施する必要がある。また、これらの変更が水位表示画面に反映されていないため、改善することが望ましい。

8.6 パッシグ・マリキナ川流域では、KOICA-II プロジェクトで警報基準水位が設定されている。決定された背景・手法を確認の上、将来の混乱を防ぐため、ダム技プロ（2012 年）と同様な（避難必要時間を考慮した）手法での設定、見直しが求められる。また、EFCOS では台風オンドイや台風ペペン災害前に設定された警報基準水位が表示されているため、画面表示を更新する必要がある。

8.7 新規流域では、洪水情報・警報発出に関する簡易マニュアルを準備する必要がある。プロジェクト NOAH では、そのようなマニュアル作成がスコープに含まれないため、観測施設の維持管理責任が PAGASA に移管される場合には、PAGASA 自身で作成する必要性がある。

関連機関間の協力システムの現状

8.8 合同調整委員会は、1992 年に設立され、流域及びダム放流に関する洪水予警報システム運用と維持管理に関する活動全般に関する責任を負う。現在、メンバーは、PAGASA、NIA、NPC、OCD、NWRB、DPWH、MMDA である。水文、通信、財務の３つの分科会から構成され、それぞれ NWRB、PAGASA、OCD/PAGASA が座長を務めている。

8.9 ダム技プロ（2012 年）では、21 の強化のためのアクションプランが立案され、種々の活動を通じて Joint Operation and Management Committee（JOMC）の強化が図られた。そのうち 6 つが完了し、15 のアクションが継続中である。これに付随して、JOMC が持つ調整機能や情報共有機能を、プロジェクト NOAH や他のドナープロジェクトで有効活用することが望ましい。

関連機関間の協力システムの課題

8.10 ダム技プロ（2012 年）の対象 3 河川（カガヤン川、アグノ川、パンパンガ川）では、FFWSDO 運用における課題が明らかになり、課題解決に向けた提言がなされた。今後、これらの提言の実行が求められる。一方、ビコール川流域では、機器の更新を 2013 年中に実施する予定となっている。機器設置後のリバーセンターと PRSD による円滑なシステム運営を目指す上で、初期段階での HMD の積極的関与が重要である。

8.11 パッシグ・マリキナ川流域では、予定される KOICA システムと EFCOS の統合に際し、他関連機関との連携を再度確認する必要がある。また、PAGASA 内の HMD と PRSD-NCR の責任分担の明確化も必要である。

8.12 JOMC は将来に渡りその調整機能が維持され、引き続き洪水予警報に関する議案を協議する最高機関として存続すると見られる。従って、JOMC 強化のためのアクションプランを更新しつつ着実に実行に移していく必要がある。また、中央では、PAGASA HMD と OCD、並びに他の中央政府機関の連携、地方では、PRSD と中央政府機関の地方出先事務所、及び地方自治体との連携が特に重要となる。

9. 通信システムと機材に関する現況および解決すべき課題

通信システムと機材の概要

9.1 PAGASA の水文・気象の予警報に使用される既存通信システムは、データ収集系とデータ伝達系に区分けされ、データ収集系は、雨量・水位（水文）と気象データを観測

局から VHF 無線・携帯電話でリバーセンターや PRSD へ送信するシステムである。データ伝達系は､収集された水文･気象データをリバーセンターや PRSD より PAGASA の気象・洪水予警報センターへ送信・監視するシステムである。

9.2 データ収集系は以下に述べる 7 つのシステムが現在までに構築されている。

- PAGASA FFWS と称されるパンパンガ川、アグノ川、カガヤン川、ビコール川流域に設置されている雨量・水位の観測システム
- NIA と NPC により管理され FFWSDO と称されるマガット、アンブクラオ、ビンガ、サンロケ、パンタバンガン、アンガットダムに設置されている雨量・水位の観測システム
- MMDA に管理され EFCOS と称されるパッシグ・マリキナ川流域に設置されている雨量・水位の観測システム
- NPC とマニラ首都圏上下水道公社（MWSS）により運営され Ipo ダム FFWS と称されるイポ、ラメサ、アンガットダムに設置されている雨量・水位の観測システム
- NPC とカリラヤ、ボトカン、カラヤン水力発電所（CBK）により運営されカリラヤダムに設置されているカリラヤ FFWSDO と称される雨量・水位の観測システム
- KOICA-I と称されるオーロラ、ハロール、アグス-ラナオ湖流域に設置された雨量・水位観測システムで LGU により管理されている
- KOICA-II と称されるパッシグ・マリキナ川流域に設置されている雨量・水位の観測システムで PAGASA が管理している

FFWS（洪水予警報システム）の現況

9.3 OECF/JICA により建設されたシステムの現況を以下に示す。

- ビコール、カガヤン－ABC システム（OECF、1980 年完成）: 一部機材は老朽化のため観測を停止中。
- ビコールは日本国無償案件（ノンプロジェクト）にて改修の予定。
- アグノとパンパンガ（日本国無償資金協力、2011 年完成) : 正常に動作中
- パッシグ・マリキナ（MMDA 管理）－日本国無償資金協力（2002 年完成）:一部の局は観測を停止中。
- 2013 年 9 月時点の FFWS の稼働状況は次のとおりである。

システム名称	雨量局 (稼働局数/全体数)	雨量・水位局 (稼働局数/全体数)
パンパンガ川 FFWS	**7/7**	**9/10**
アグノ川 FFWS	**3/3**	**8/8**
カガヤン川 FFWS	**-**	**3/5**
ビコール川 FFWS	**2/3**	**2/6**
EFOCS Phase II	**4/7**	**8/11 （水位計のみ)**

9.4 KOICA により建設されたシステムの現況を以下に示す。

- オーロラ、ハロール、アグス-ラナオ湖（KOICA-I, 2009 年完成）: アグス-ラナオ湖を除いて稼動していない。

- パッシグ・マリキナ（KOICA-II）：以下の問題が発生している。
  - ・ 観測データの信憑性が低い。例えば、2013 年 4 月 20 日のパシッグ市庁の気温が 15°C 前後と記録されている。4 月のマニラの気温は 25°C から 35°C である。
  - ・ データ欠測が多い。10 分間隔で計測し観測データを伝送しているが、概ね多くの観測局において、1 時間で約 2 回のデータが欠測している。VHF 無線と携帯電話のよる 2 重化システムを構築しているが、信頼度が低い。
  - ・ 防災システムとしては信頼性の低いシステムとなっている。マイクロ波多重の周波数帯は 5GHz（NTC よりのライセンス不要な無線 LAN の周波数帯）を使用しており、混信の可能性が高い。
  - ・ 計画・設計に問題がある。例えば、10 ヶ所の放流警報施設の内、3 ヶ所が 2012 年 8 月のマニラ首都圏の豪雨により水没しており、修復されていない。

PAGASA の気象監視システムの現況

9.5 PAGASA の気象監視システムの概要は以下のとおりである。

- 全国気象通信システム（OECF、1995 年完成）：携帯電話網との混信より 1990 年代後半から稼働を停止している。
- 韓国、台湾など無償案件を含めた 15 プロジェクトにより 2008 年から 2012 年にかけて 75 箇所 AWS（自動気象局）と 80 個所の ARG（自動雨量局）を設置。KOICA-I を除いて稼働中。
- ASTI により以下の観測局の設置された（2013 年 1 月 17 日の時点）。
  - ・ 100 個所の AWS（自動気象局）
  - ・ 80 個所の ARG（自動雨量局）
  - ・ 64～74 個所の WLS（水位局）

9.6 FFWS の通信システムと気象監視の通信システムの概要は以下のとおりである。

- 雨量・水位観測データ伝送は VHF 無線（150 MHz 帯）の専用回線であり、信頼性があり堅牢である。
- PAGASA HMD と関連機関（OCD、DPWH、NIA、NPC）を結んでいる通信システムは、7.5 GHz 帯のマイクロ波無線、光ファイバーケーブルから構成されており、信頼性が高く堅牢であるバックボーンとなる専用回線である。
- 上記の専用回線に代わり公衆回線網（PLDT/GLOBE）を使用して、HMD と NWRB, ダム事務所間の電話・ファックスに使用している。
- 携帯電話は音声通話やショート メッセージ サービス（SMS）として利用されている。
- NOAH プロジェクトにおいて、気象観測データ用に携帯電話 SMS が主回線、衛星回線がバックアップとして使用されている。また、水位データ用には携帯電話 SMS が主回線として使用されており、バックアップ回線はない。
- IP-VPN 回線が PAGASA 気象部と PRSD 間のデータ通信回線に使用されている（同様 NOAH と EFOCS 間も適用されている）。
- レーダー気象データは衛星通信回線を使用しており、WMO や他の国際機関との間で気象データを共有している。

FWSDO（ダム放流予警報システム）の現況

9.7 FFWSDO（ダム放流予警報）の現状は以下のとおりである。

- FFWSDO-I (OECF、1986 年完成)のシステムでは、幾つかの機材は耐用年数を経過しており、稼働していない。
  - ・ 運用・管理組織：アンガットダム（NPC）とパンタバンガンダム（NIA）
- FFWSDO-II (OECF、1994 年完成) のシステムでは、幾つかの機材は耐用年数を経過しており、稼働していない。
  - ・ 運用・管理組織：ビンガ、アンブクラオダム（NPC）とマガットダム（NIA）
- San Roque Telemetry（OECF、2004 年完成）のシステムは、稼働していない(アンプカオ中継所への落雷による機材の損傷とサンロケダム設置のコンピュータシステムの不具合)
  - ・ 運用・管理組織：サンロケダム（NPC）
  - ・ 2013 年 9 月時点の FFWSDO の稼働状況は次のとおりである。

システム名称	上流域の雨量局 (稼働局数/全体数)	ダムと下流域の水位局 (稼働局数/全体数)	放流警報局 (稼働局数/全体数)
マガットダム FFWSDO	**4/6 *1 & 6/6 *2**	**1/2 *1 & 4/4 *2**	**11/15 *1 & 6/6 *3**
パンタバンガンダム FFWSDO	**5/5 *4**	**1/2**	**17/19**
ビンガ・アンンブクラオダム FFWSDO	**4/4**	**2/2**	**-**
サンロケダム FFWSDO	**0/1 *5**	**0/1 & *5 1/1 (dam)**	**16/18**
アンガットダム FFWSDO	**3/4**	**1/3 (dam)**	**17/17**

*1: 旧 OECF により建設された VHF 無線によるテレメータ局
*2: NIA 資金により建設された衛星と SMS によるテレメータ局
*3: NIA 資金により建設された放流警報局
*4: NIA 資金により建設された VHF 無線テレメータ局であり、テレメータデータは PAGASA WFFC 宛てに伝送されていない
*5: NPC 資金により建設された VHF 無線によるテレメータ局

- イポダム FFWS（2012 年完成-比国資金）システムは、PAGASA では監視できない状態。
  - ・ 運用・管理組織：アンガット（NPC）、イポダム（MWSS）
- カリラヤダム FFWSDO（2013 年完成-比国資金）は、幾つかの機材が機能を発揮していない。
  - ・ 運用・管理組織：カリラヤダム（NPC）

9.8 2009 年から 2012 年 12 月に実施されたダム技プロにおいて、ダム水位計の補修、放流警報装置の移設（ビンガダムからサンロケダム）、PAGASA WFFC のダムデータ表示、ビンガ・アンブクラオダムのテレメータデータ表示、試験機材の納入などが実施された。

9.9 比国政府資金により 2012 年に以下内容が実施された。

- 無償資金協力事業により納入された NIA-OCD 間の 18 GHz 簡易多重無線装置の OCD- EFCOS への移設作業（PAGASA WFFC にて EFCOS データの監視が可能となった）。
- 無償資金協力事業により建設されたパンパンガ・アグノ FFWS 観測データの NOAH プロジェクトへのデータ転送
- PLDT 回線を使用した IP-VPN 技術による気象データの配信システム（PAGASA 本部、PRSD、気象レーダーなど 19 カ所を接続）（S-22 頁にて詳述）

機材調達の将来計画

9.10 NOAH プロジェクトにおいて、2013 年 12 月末までに約 750 局の自動気象装置、自動雨量計、自動水位計を設置する計画である。

9.11 カガヤン・デ・オロ川流域において、KOICA により 7 個所の自動雨量計、2 個所の自動水位計設置の計画がある。設置計画の詳細は今後策定される予定である。

9.12 日本のノンプロジェクト無償資金協力によりダバオ川流域への雨量計、水位計などの納入計画が有る。設置計画の詳細は今後策定される予定である。

9.13 米国貿易開発機構（USTDA）資金による実施可能性調査が 2012 年に実施されたが、PAGASA ではこの計画を実現化することはないとのことである。

- ルソン島からミンダナオ島までの冗長化されたマイクロ波のシステムの構築
- VHF 無線に代わる衛星通信によるテレメータ通信システムの構築

9.14 PAGASA によれば、ケソン市の WFFC と新規リバーセンターを接続する通信システムの候補として、拡張が計画されている全国電力送電会社（NGCP）の通信システムを流用する計画もあるとのことである。PAGASA は過去のパンパンガ・アグノ FFWS において、NGCP より通信回線を借りたことがあるので、同様に NGCP の通信回線の借用が可能と考えられる。

- NGCP ではレイテ-ミンダナオ接続計画と称される電力網の拡張計画がある。2018 年完成を目指し、5 億ドルを投資して、レイテ島からミンダナオ島のカガヤン・デ・オロ市まで送電線を敷設し、それに付随して光とマイクロ波多重の通信システムを構築する計画である。
- 上記の拡張計画が予定通り完成し、電力通信網と PAGASA 通信網を接続すれば、最速で 2018 年以降、アグサン川、タゴロアン川、カガヤン・デ・オロ川流域などミンダナオ島北部のリバーセンターとケソン市 WFFC との接続が可能となると見込まれる。
- しかしながら、ミンダナオ島内での電力網拡張計画が明らかにされていないため、ミンダナオ島南部のタグム-リブガノン川、ダバオ川、ミンダナオ（コタバト）川、ブアヤン-マルンゴン川について、PAGASA は衛星通信または新規マイクロ波無線回線により前述の NGCP 通信回線との接続を計画する必要がある。
- ビサヤ地方のハロール川に関しては、PAGASA が独自の衛星通信などを計画する必要がある。

9.15 比国の通信キャリアである PLDT は、ボホール島・セブ島間とボホール島・ミンダナオ島（カガヤン・デ・オロ市）間の光ケーブル敷設を計画している。NGCP と同様に、近い将来においてこの回線を PAGASA が利用できる可能性があり、PAGASA WFFC とミンダナオ島北部の流域を結ぶ通信回線の候補となり得る。

機材の運用面から見て解決されるべき課題

9.16 KOICA-II プロジェクトは前述したように様々な問題が発生しており、今後の検証が必要である。

9.17 NOAH プロジェクトに関しては、以下のとおりである。

- 機材故障や盗難の発生が懸念される。状況を定期的にモニターする必要がある。
- 水位計センサーは雨水の侵入により劣化の可能性があるので、機材の定期点検が必要である。
- PAGASA が実施している FFWS と NOAH プロジェクトでは、雨量・水位計の計測間隔に違いがある。10 分もしくは 15 分間隔への統一が必要である。
  - ・ PAGASA FFWS： 30/60 分間隔（マニュアル操作により 10 分間隔も可能）
  - ・ NOAH プロジェクト： 10/15 分間隔
- 水位計測に関する目的の違いは以下のとおりである。計測結果を適切に用いるためには計測精度を確認する必要があり、マニュアルでの計測と比較・検証する必要がある。
  - ・ PAGASA FFWS: 正確な水位計測・流量推定（例：圧力式の場合、20m の測定範囲に対して、+/-2cm の精度である）
  - ・ NOAH プロジェクト： 洪水発生の感知（精度は不明）
- PAGASA の FFWS の基準/指針は、日本の国土交通省のものが適用されているが、NOAH プロジェクトにおける基準/指針は明確ではない。フィリピン国として、基準/指針を設定すべきである。

9.18 FFWSDO プロジェクトに関しては、機能を停止している幾つかのテレメータと放流警報システムを修復する必要がある。

9.19 以下の基幹通信システムの修復が必要である。

- PAGASA WFFC とツゲガラオリバーセンターとマガットダム事務所
- アパリレーダー観測所とツゲガラオリバーセンターとマガットダム事務所

9.20 IP ネットワークやコンピュータプログラムから構成されている、PAGASA WFFC の FFWS の監視システムの運用・管理の強化を図る必要がある。

- 既存 FFWS システムの月報作成機能の活用。
- 既存 FFWS システムのアラーム設定レベル（2 段階から 3 段階）と H-Q 計算式の修正作業。

既存機材の運用・維持管理

9.21 PAGASA 内部の組織機能として、HMTS 課が PAGASA 保有機材の運用と維持管理に当たっている。他機関が保有する機材の運用と維持管理は他機関の責任下において実施されている。

9.22 HMD は年 4 回の定期点検をパンパンガ、アグノ、カガヤン、ビコールのシステムで実施しており、事故の対応も適切に行っている。以下に述べるように、故障は発生しているが適切な保守作業が実施されており、今後は若手技術者の雇用、育成を促進しながらさらに適切な維持管理能力を強化していく必要がある。

- パンパンガ川流域のペネランダ水位局の 2012 年 8 月の鼠によるケーブル断線事故
- 2013 年 7 月パンパンガ川流域のマヤプヤップ雨量・水位局の水位データが破壊行為（PAGASA によれば、局舎のドアーが何者かにより開けられた形跡があると

のこと）によりデータ伝送が停止した（雨量データは伝送しているとのこと)。川の水位が高いため、PAGASA は詳細なチェックを現場で行えなかったとのことだが、PAGASA は速やかにその機能を復旧すべきである。

9.23 PAGASA 気象部の観測機材の維持･管理業務は外部企業へ外注する計画とのことである。

既存機材の運用・維持管理の課題

9.24 NOAH プロジェクトが PAGASA に移管された場合には、現有の HMD のスタッフの要員を増強する必要がある。また、新規リバーセンターに供される機材の保守・点検スタッフの採用と教育が必要である。

予警報の関係機関への伝達

9.25 アグノ川､パンパンガ川流域においては洪水予警報マニュアル（Flood Warning Manual, Dam Discharge Manual）が整備され、PAGASA から関係機関への情報伝達は基本的にこれらのマニュアルに従って運用されている。一方、PAGASA HMD と結ぶ自営回線がないビコール川、カガヤン川流域については各リバーセンターから「Basin General Flood Advisory」のみ地域の関係機関に提供している。パッシグ・マリキナ川流域は MMDA 所管であるため予警報発報に関し現状では PAGASA は直接関与してない。また、ミンダナオ島などの地方 14 流域に関しては PAGASA HMD から「Region General Flood Advisory」のみ PRSD 経由で地域の関係機関に発信している。

9.26 アグノ川、パンパンガ川流域以外は情報伝達手段を公衆電話回線に依存しているため、雨天時に接続が悪い、電話の補完として使用される SMS は長いテキスト送信ができない、また、インターネットは接続が悪いことが多く、回線速度が安定しない等、の課題を抱える。

コミュニケーションシステム（**OCD**）

9.27 OCD の情報伝達網の通信手段は、主として公衆回線電話・ファックス及び補完的にインターネット電子メール及び SMS が利用されている。また、European Commission から供与されたインマルサット可搬型衛星携帯がルソン島内、8 箇所の Regional Center に配備されており、公衆回線が途絶した場合の緊急用に使用されている。さらにマニラ市内の関係機関への緊急連絡無線として VHF 無線機が配備されている。

9.28 一方、市町村、バランガイレベルへの OCD コミュニケーションシステムの主な通信手段は公衆回線電話と携帯電話であり､災害情報の確実な伝達という観点から改善が必要である。FAX はメトロマニラ周辺の市町村では整備されているものの地方においては未だ未整備の市町村が多い。また、個人所有の携帯電話が使用されていることも災害時の情報統制という観点から好ましくない。また、公衆回線電話に依存しているため､災害時の呼集中による接続不能､加入者回線の信頼性､双方向通話の確保等々、に課題がある。本邦の例であるが市町村防災行政無線システムがアナログ方式からデジタル方式に移行する理由の 1 つが双方向通信の確保にある。

PAGASA の情報通信技術

9.29 従来、PAGASA は HF 通信、VHF/UHF 通信、マイクロ多重、衛星、光ファイバー通信等を伝送手段として気象情報を収集してきた。しかし、近年の情報通信技術の発展に伴い IP ネットワーク技術を導入するため、PAGASA は各部署から人材を集め ICT グループを発足させた。ICT グループは現在、11 名で構成され PAGASA 長官の直下組織として活動している。

9.30 信頼性の高い気象予測は正確な気象データをもとに実現される。PAGASA はこれらの気象データを地方から本部に伝送しているが PAGASA ICT を利用することで情報収集系及び配信系システムが改善される。現在までに、ICT 技術により PRSD 4 か所（El Salvador Mindanao, Tuguegarao Northern Luzon, Legazpi Southern Luzon, Mactan Visayas）とネットワーク接続が完成している。ネットワークは IP-VPN あるいはインターネット VPN によって構成されている。

9.31 PRSD は IP-VPN もしくはインターネット VPN により接続される。PLDT が IP-VPN サービスを提供し、Comclark、Globe、Bayantel 等、インターネットプロバイダーが回線帯域保証付き（Committed Information Rate）インターネット VPN を提供している。ロードバランサーを使用してこれら複数回線に負荷分散すると同時に、1 つの回線がダウンしても他の回線で補完する構成としている。ファイアーウォールは設置されていないため L3 スイッチにより外部からのアクセスを制限する。WEB、DNS、DHCP、NTP 等のサーバーを DMZ セグメント内に配置し外部公開している。停電対策として各装置に小規模の交流無停電装置が付加されているがシステム全体としての無停電化はなされていない。

PAGASA の情報通信技術の課題

9.32 PAGASA の情報通信技術は導入段階にあり、以下の課題を抱える。

- ICT エンジニアの育成及び組織改革、特に HMTS 課の技術者教育
- システムセキュリティを構築するため PAGASA セキュリティ方針の策定
- PAGASA の気象部門と水文部門の通信ネットワークの接続及びリアルタイムデータ共有
- ロードバランサー、コアルーターなどネットワーク内の主要装置の二重化
- ネットワーク攻撃に対処するため UTM（統合型脅威管理）システムの導入
- システム全体の無停電化、電源の信頼性向上

10. 本邦関連技術の評価

本邦関連技術適用の基本戦略

10.1 衛星関連技術の発展は目覚ましく、今後の FFWS の整備に大きく影響を及ぼす。日本国政府は衛星による気象観測情報と数値モデルの利用を強化している。1 例として ICHARM により開発された洪水流出モデルである IFAS がある。

10.2 日本において長年の運用実績があるテレメータ関連技術は比国の FFWS へ適用可能である。

検討すべき候補としての本邦関連技術

10.3 降雨レーダー、衛星による降雨観測と流出解析、地上波デジタルテレビ、災害情報多重配信技術、日本において長年の運用実績がある技術を候補とする。

レーダーによる雨量観測

10.4 PAGASA では現在 9 基のドップラーレーダーを運用しており、さらに 5 基を追加、1 基を修復予定であり、合計 15 基となる予定である。既存 9 基のうち、JICA ではアパリ、ビラク、ギウヤンに S バンドドップラーレーダーを導入した。

10.5 ドップラーレーダーにより雨量を推定するためには適切なキャリブレーションを実施しなければならない。PAGASA では現在次の検証を実施している。アグノ川流域とパンパンガ川流域においてスービックレーダーによる推定雨量の検証を実施し、ヒナトゥアンレーダーとセブレーダーにおいて相互比較、検証作業を実施している。

10.6 S バンド、C バンドレーダーは台風など広い範囲の観測に用いられる。X バンドレーダーは小規模気象擾乱の監視に用いられる。

10.7 上記 15 基のドップラーレーダーに加え、X バンドレーダー（可搬型）が調達され、試験運用される予定である。運用段階にいたるまで数年は要すると思われるので、当面の間は導入済みの C バンドおよび S バンドレーダーを最大限活用する方策を講じる必要がある。

10.8 レーダーそのものの技術革新に加えて、レーダー推定雨量の補正技術も発達してきている。日本ではドップラーレーダーによる推定降雨量は地上雨量計により補正され、「解析雨量」として配信されている。同様のレーダー雨量補正技術は比国においても適用可能であると考えられる。

衛星による降雨観測と流出解析

10.9 IFAS は ICHARM により開発された降雨流出モデルであり、衛星降雨プロダクトを入力可能なインターフェイスを備えている。ADB 資金によりカガヤン川およびパンパンガ川に適用された。また、IFAS のトレーニングが本邦研修により実施された。

10.10 GSMaP は JAXA により開発された衛星降雨プロダクトであり、ADB 資金により IFAS の入力データとして比国に導入された。

10.11 カガヤン川において IFAS を実運用に持ち込むためには、追加の雨量計の設置、地上雨量データを IFAS 入力用データに自動変換するシステムの構築が必要である。

10.12 GSMaP は配信が 4 時間遅れとなる、精度が低いという弱点があるが、雨量観測網が存在しない地点でも活用できる利点がある。これらの特徴を考慮すると地上雨量計の設置密度が希薄で、かつ、洪水到達時間の長い大流域に適した手法である。ミンダナオ島に位置するミンダナオ川流域は流域面積が約 23,000km^2 であり、比国で 2 番目に大きな流域である。また、治安上の問題があることから地上雨量計の設置が進んでいないため、IFAS の導入に適している。さらに、ミンダナオ島に位置するアグサン川も同様の状況にあるため IFAS の導入に適している。

地上デジタルテレビ放送

10.13 地上デジタル TV 規格には、大別して日本方式、欧州方式、北米方式の 3 種類が存在している。日本で開発実用化された規格は ISDB-T 方式と言われ、(1) マルチメディアに対応し画面分割により文字、画像などデータ放送が可能、(2) OFDM 変調とインターリーブ技術によりマルチパスフェージングに強く車移動中でも良好な受信が可能、(3) 送信スペクトラムの 6M 帯域は 13 セグメントで構成される。

10.14 そのうち 1 セグメントを使用して個別のコンテンツ放送が可能（ワンセグ放送）、これらの特徴のうち (1) 及び (3) の機能は災害発生時の警戒・避難情報の伝達に利用されている。

10.15 比国においては 2010 年 6 月に日本方式 ISDB-T を採用すると NTC から発令された。しかし、2011 年 3 月、欧州方式 DVB-T が日本方式よりも優れているとの異議が提出されたため、採用をめぐり未だ両方式の審議中である。

10.16 比国における地上放送完全デジタル化には未だ相当の期間を要すると推察される。上述の (1) 及び (3) の技術は災害時に住民への迅速かつ正確な警戒・避難情報の提供に有用であり、比国の地上放送完全デジタル化が実現された時点で導入が期待される。

多層的手段を用いた警戒・避難情報配信

10.17 警戒・避難情報発信サーバーから多層的な情報伝達手段を用いて情報を発信するシステムでプラットフォームサーバーを立て発信情報を一元管理する。

10.18 プラットフォームサーバーにはクラウドコンピューティング技術を採用している。

10.19 地域住民への情報伝達手段は、60MHz 帯デジタル市町村防災行政無線システム、コミュニティ FM ラジオシステム、地上デジタル放送による情報配信（ワンセグ、データ放送)、携帯電話避難メール等、本邦に於いて実用化されている多彩な技術を多層的に利用する。

10.20 警戒・避難情報の住民への報知は、特定の情報手段のみでは十分に伝達できないことは過去の災害事例から既に知るところである（例えば、60MHz 市町村防災行政無線システムは雨音で放送が聞こえない、家の中にいると聞こえない等の問題が指摘されている。)。複数の情報手段を多層的・複合的に運用することが重要である。

10.21 通信インフラが本邦と比べて発達途上にある比国において本邦技術をそのまま導入することは困難であり整備に時間を要するが、複数伝達手段を用いて警戒・避難情報を発信する基本概念は検討すべき課題である。

成熟した技術の応用

10.22 日本の国土交通省において開発・利用されている成熟した技術は洪水予警報システム（河川・ダム）に使用されており、技術の有効性は実証されている。これら技術は以下のように PAGASA の既存システムの強化に応用が可能である。

- VHF/UHF 無線テレメータ：　雨量・水位観測局からリバーセンターへのデータ伝送に応用できる。

- スピーカーとサイレン： 既存ダム放流警報設備の更新や新規の放流警報システムへ応用する。2011 年の東日本大地震の教訓により、警報を知らせる音声の遠方通報や明瞭化の技術の検討・開発が実施されている。
- 5.8-38GHz のデジタル無線システムと RPR（レジリエントパケットリング）装置： これらの組み合わせによる回線構成 2 重化を、PAGASA のバックボーン回線へ応用する。
- WDM(波長分割多重化)技術： この技術は、将来 PAGASA のネットワーク容量を増加した場合（光通信システムのケース）や NGCP 通信網と共存する場合（新規リバーセンターと PAGASA WFFC との通信システムのケース）に応用できる。

10.23 比国では洪水予警報関連機材の基準/仕様がないため、PAGASA が主体となって策定する必要がある。その際、以下の国土交通省標準仕様書やガイドラインが参考となる。ただし、これらをそのまま踏襲するのではなく、国際的に広く採用されている基準などを参考としながら詳細を検討する必要があり、検討作業を通じた PAGASA の能力強化が可能である。

- テレメータ装置標準仕様書
- 直流電源装置標準仕様書
- マイクロ波無線装置標準仕様書
- 電気通信設備設計指針（ガイドライン）
- 電気通信設備の点検指針（ガイドライン）

洪水予警報システムの統合

10.24 国土交通省では無線通信が認められるようになった昭和 29 年（1954 年）以降、雨量・水位のモニタリングシステムを構築し、技術の進展に応じて数度のシステム変更を行いながらも現在に至るまで運用を行っている。システムの発展は 5 段階に分けられ、①初期の無線テレメータシステム（昭和 29 年、1954 年）、②河川情報システム（昭和 50 年、1975 年）、③新河川情報システム（昭和 62 年、1987 年）、④総合河川情報システム（平成 8 年、1996 年）、⑤統一河川情報システム（現在）、となる。

10.25 ④の総合河川情報システムは国土交通省管轄 109 水系をカバーするテレメータシステムとして設計され、マルチベンダ環境のもとシステム間相互接続を保証することが重視された。結果として、低スペックのマシンや通信回線でも動作可能な「テレメータ観測データの送受信伝送仕様」としての標準化を行った。

10.26 ⑤の統一河川情報システムは、レーダーとテレメータの融合、道路局や気象庁との情報共有化という要請に応じるため、取り扱いデータの拡張を目指して設計され、拡張性に優れた XML (Extensible Markup Language)と呼ばれる汎用フォーマットを採用した。従来のバイナリ形式ではデータ容量が小さい半面、データそのものと、その意味を示す仕様書の 2 種類の情報を準備しなければならない。よって、システムの変更やシステム間連携などは仕様書を理解したエンジニアが作業を行う必要がある。一方、XML 形式ではデータの中にデータ定義情報を埋め込むことができるため、システム変更に際してもある程度の自動化が図れる。ただし、データ容量は大きくなるため情報処理システムや通信回線に負荷がかかるという特徴がある。

10.27 PAGASA HMD では、これまで OECF/JICA による PABC システムを運用してきたが、近年、EFCOS からのデータ転送、KOICA II システムの整備などが行われ、各システムの連携が必要となっている。本邦でのマルチベンダ環境によるシステム整備の経験は、PAGASA のシステム改善にも役立つものと考えられる。

11. 対象流域における段階的開発に関する予備検討

検討手法

11.1 前章までの検討結果に基づき、本章では特定された課題の解決に向け、優先的なプロジェクトの構成要素に関する予備的な検討を実施した。

重要課題に対する改善策

11.2 観測施設の位置と密度は適切に計画される必要がある。最初に、観測施設の区分（レベル分け）と共に目標とする観測データの精度検討や既設観測ネットワークの評価が重要である。

11.3 関連機関で共有すべき洪水情報の内容を決める必要がある。個々の流域（特にミンダナオ島）から PAGASA 洪水予警報センターへのデータ転送とそこでのデータ蓄積は、まず HMD 内のデータ管理システムの改善が先行されるべきであり、慎重な検討が必要である。

11.4 河道測量データは、洪水予警報にとって非常に重要な情報である。最初に水位観測所における警報基準水位を設定するための河道横断情報が必要となる。その後、河道横断測量や H-Q 式設定のための流量観測などの調査を継続的に実施する。その際、リモートセンシング技術や、LIDAR・ADCP（ドップラー式流速計）等の有効活用も考慮する。

11.5 各流域の特徴に適した流出解析モデルの選定が必要である。しかし、特に新規流域でデータ蓄積が不十分な初期段階では、簡易な水位相関による予測が実用上有利と考えられる。その後、データの蓄積状況を見てモデルの開発を進める。

11.6 PAGASA は洪水情報や氾濫情報を関連自治体に提供する責任がある。氾濫解析モデルはそのためのツールの一つだが、モデルの開発の前に、河道データやデジタル標高図、実績洪水波形などの必要情報の蓄積を優先させる必要がある。

FFWS/ FFWSDO の将来開発に向けた目標レベルの設定

11.7 主として日本の支援により開発が進められてきたパンパンガ川、アグノ川、ビコール川、カガヤン川、パッシグ・マリキナ川の既設 5 流域では、ビコール川を除き、ダムや治水構造物が付帯する流域としての洪水予警報システムが開発されてきた。しかし、今後 FFWS を整備していく新規流域では、基本的にダムや治水構造物が存在しない、または建設計画も策定されていない。ダムが存在しない流域では、より効果的、効率的な洪水予警報システムを考案する上で、日本における小流域で利用されているシステム構成が参考となる。

11.8 日本の小流域では、比国における州に該当する県レベルの河川管理部局が洪水予警報システムを運営している。2005 年の水防法改訂により、観測地点の上下流の流下能力および避難所要時間が新たに警報水位設定に反映されることになった。一方、気象庁

の発出する洪水警報は、2010 年より県レベルの空間解像度であったものが市町村レベルの解像度に変更された。

11.9 日本における小流域の洪水予警報システムの基本構成は、比国の新規 FFWS 対象流域の計画策定に際し参考となる。これまでの議論を通じ、PAGASA 側は、特に新規に機材の設置が必要な流域においては、適切な技術基準の設定や段階的な整備に向けた戦略の必要性を十分認識している。

11.10 日本における開発経緯のレビューおよび PAGASA と機構比国事務所との協議を通じて、対象流域における段階的開発のための目標レベルを 3 段階（レベル 1、2、3）に設定し、後述するケーススタディを行った。

段階的な開発手法の適用

11.11 開発ニーズを抽出するための流域として、全 19 流域の中から、最終的に以下に示す 13 流域が選定された。

- ルソン島：カガヤン、アグノ、パンパンガ、パッシグ-ラグナ・デ・ベイ、ビコール
- ビサヤス：ハロール
- ミンダナオ島：アグサン、タゴロアン、カガヤン・デ・オロ、ダバオ、タグム-リブガノン、ミンダナオ（コタバト)、ブアヤン-マルンゴン

11.12 中間報告書（2013 年 5 月）の段階では、ブアヤン-マルンゴン川流域を除く 12 流域を優先的なニーズがある流域としていた。その際、既設 5 流域は引き続き優先的に、FFWS のさらなる発展に継続して取り組んでいく必要があるとされた。それ以外の流域に関しては、PAGASA の方針として、できる限り優先的に多くの流域を取り扱うこととなった。

11.13 ブアヤン-マルンゴン川流域に関しては、「River Center Project」のもとリバーセンター建設の調達のための第一グループに入ったため取り上げられた。また、マンドゥログ川流域については、上記流域には選定されなかったが、PAGASA HMD の情報によれば、リバーセンターをエルサルバドル（東部ミサヤス州）の政府用地内に設置し、カガヤン・デ・オロ川、タゴロアン川、イポナン川流域とともに同時に機器の設置や観測体制の強化が進められる予定となっている。

11.14 テレメータシステムが存在しない新規開発流域においては、暫定的にレベル 1 の整備を目標とする。現在、HMD の元で進行中の「ビコール川洪水予警報システム整備プロジェクト」を参照すると、全整備手順は 10 段階に分割できる。そのうち現状の HMD では、調査から基本設計までの 6 段階を主に担当しているため、これに焦点を当て開発ニーズの抽出を実施した。検討対象としては、優先流域の一つであるミンダンナオ島のアグサン川流域を取り上げた。

11.15 開発ニーズの抽出検討結果を以下に示す。

アグサン川流域の将来開発ニーズ（**HMD** の職務に関連）

	分　野	将来開発ニーズ
1	データ/情報収集	-
2	現地踏査	-現地における各調査に関する研修
3	水文解析	-IFAS（洪水流出解析モデル）利用に関する研修 -洪水予警報に焦点を当てた応用水文学に関する研修
4	システム設計（気象水文学的見地から）	-流出解析モデルや氾濫解析モデル作成に関する研修
5	システム設計（データ共有/通信の見地から）	-通信システム・ネットワークの計画立案に関する研修
6	基本設計（初期積算を含む）	-簡易土木構造物や通信施設の設計に関する研修

出典：調査団

11.16 既設 5 流域では、現在のシステムをレベル 3 に引き上げるための維持管理強化がアセスメントの主眼となる。開発ニーズの抽出は、HMD 職員へのインタビュー結果や収集したデータ/情報に基づき実施した。

11.17 カガヤン川及びパッシグ-ラグナ・デ・ベイの 2 流域を対象にニーズアセスメントを行った。カガヤン川流域は近年、様々な日本側からの支援が展開されている。また、パッシグ-ラグナ・デ・ベイでは、PAGASA は今雨期から EFCOS と KOIKA の観測データをもとに MMDA と協力しつつ洪水予警報活動を開始することを予定している。従って、早い段階で開発ニーズを把握しておくことが重要と判断した。

11.18 開発ニーズの抽出結果を以下に示す。

カガヤン川流域の将来開発ニーズ

	分　野	将来開発ニーズ
1	流域/河川モニタリング	-PAGASA 気象観測所や NOAH 観測所の有効活用（観測所管理規則の開発）
2	洪水予警報のためのデータ収集	-アパリにおける雨量レーダー観測値の活用とツゲガラオサブセンターへの予報官の早期派遣
3	データ管理	-データベースの統合 -データベースに登録するデータの更新 -関連機関へのデータ転送システム
4	流量観測	-水位観測所の H-Q 式の定期的レビューと更新
5	洪水警報水位の設定、更新	-主要水位観測所における警報基準水位の見直し（「ダム放流に関する洪水予警報能力強化プロジェクト」での提案手法）
6	洪水予報	-既存流出解析モデルの全流域への拡張及び更新 -IFAS の強化 -氾濫解析モデルの開発
7	洪水情報の発出	-洪水情報の迅速な配信のためのより信頼性の高い通信手段の開発 -観測所の設置
8	洪水発生後の調査	-HMD 内セクション間の柔軟な任務の割り当てと輪番制に基づく連携強化
9	教育訓練	-OCD 地域事務所（Region 2）や地方自治体との連携
10	テレメータと通信	-洪水予警報に関する機器調達標準基準の開発 -信頼性の高い通信システムの確立

		-ツゲガラオサブセンターから州災害リスク軽減管理評議会への情報伝達のための施設改善
11	洪水訓練	-（「ダム放流に関する洪水予警報能力強化プロジェクト」での提案手法に基づく洪水訓練活動が 2013 年から開始されている）

出典：調査団

パッシグ-ラグナ・デ・ベイ流域の将来開発ニーズ

	分　野	将来開発ニーズ
1	流域/河川モニタリング	-適切な管理のために NOAH 観測所の急激な増加を踏まえて既設観測所の階級区分が必要
2	洪水予警報のためのデータ収集	-データ入力・転送・洪水情報への変換等の効果的なシステムの構築
3	データ管理	-KOICA、EFCOS、NOAH、UNDP/AusAID（レジリエンスプロジェクト）等、個別既存システムの統合
4	流量観測	-ドップラー式流速計を用いた定期流量観測の推進
5	洪水警報水位の設定、更新	-洪水警報水位の統一定義の徹底と、主要水位観測所における警報基準水位の見直し、更新
6	洪水予報	-NOAH により開発された流出解析モデルが洪水予警報に利用できるかどうかの判断
7	洪水情報の発出	-水位変動や雨量情報を必要とする地域住民への洪水情報の発信に関する統一されたルールの検討
8	洪水発生後の調査	-例外を設けない洪水発生後調査の実施徹底
9	教育訓練	-レジリエンスプロジェクトの経験・教訓の適用
10	テレメータと通信	-NOAH システムの開発に携わった ASTI 職員の PAGASA HMD への異動と NOAH 観測所の統合（将来的に PAGASA が NOAH の維持管理に責任を負う場合）
11	洪水訓練	-レジリエンスプロジェクトのもとで、地方自治体を交えた洪水情報発出も統合した洪水訓練の実施（「ダム放流に関する洪水予警報能力強化プロジェクト」でアンガット、マガットダムにおいて実施した訓練と同様）

出典：調査団

将来開発計画の構成要素

11.19　前節までの開発ニーズの抽出検討結果に基づき、以下に開発プランの考えられうる構成要素について検討し、表にまとめた（参照：表 11.5.1～11.5.3）。

(1) プラン A：レベル 1 を目指した新規流域（未テレメータ化流域）の開発（優先順位 1 位）

(2) プラン B：テレメータ化（FFWS/FFWSDO）されている既存流域のレベル 3　を目指した改善と強化（優先順位 2 位）

(3) プラン C：新規流域（未テレメータ化流域）のレベル 1 からレベル 2 さらにはレベル 3 への強化（優先順位 3 位）

プラン A と B の各構成要素は、予算規模、工程、支援スキーム等の内容に応じて組合せが可能である。また、プラン C は原則的にプラン A 完成後に実施されると想定した。尚、ここでは河川流域ごとの優先順位付けは行っていないが、項目 11.11 で協力ニーズ抽出の対象（PAGASA の整備方針に準拠した）とした 13 流域を、（リバーセ

ンター建設や観測施設の設置状況、等）準備の進捗度に合わせ、プラン A の活動項目を実施に移していくこととした。尚、上記整備目標の各レベルの内容は以下の通りである。

(1) レベル 1： リバーセンター設立
- 事務所建設
- 雨量・水位観測施設の設置（最重要地点のみ）
- 水位観測地点の測量（河道横断や量水標のゼロ標高など）
- 地方自治体とのコミュニケーションラインの確立

(2) レベル 2： テレメータシステム構築
- リバーセンターと観測施設を結ぶテレメータ施設の導入
- 雨量・水位観測施設の増設
- 河川縦横断測量、流量観測
- 水位相関法による洪水予測
- リバーセンターから PAGASA WFFC までのデータ転送システム導入

(3) レベル 3： FFWS 業務の強化
- さらなる雨量・水位観測施設の増設
- LIDAR や ADCP 技術の適用
- 洪水流出モデルや氾濫解析モデルの開発
- CCTV などの洪水監視システムの導入

12. 将来の発展に向けての行動

洪水予警報対象流域の拡大に向けての提案（アプローチ）

12.1 PAGASA では、今後、洪水予警報の対象流域を 5 流域から 18 流域へ拡大する予定である。PABC システムをはじめとした既存システムはこれまで個別に導入してきたため、各々独立したシステムとなっている。このため、今後のモニタリングネットワークの拡大に向けて、以下のアプローチが必要である。

- モニタリングネットワークシステムの改善・統合： 中央司令部として WFFC は全ての観測データを収集し、全国の降雨・洪水の状況を分析する必要がある。このため、全ての地上観測網（各流域の洪水予警報システム、気象部所管の観測網）を統合し、また、リモートモニタリングシステム（地上レーダーや衛星など）との連携を図る必要がある。一方、リバーセンターにおいては WFFC と同様のデータを受信し、担当地域の降雨・洪水状況を分析し、LGU とコミュニケーションを図る必要がある。このため、気象部門による観測データをリバーセンターに送信する必要がある。
- 既存システムの変更： 各流域の既存洪水予警報システムはドナープロジェクトにより整備されてきた。今後の安定的、効果的な運用のためには、維持管理だけでなくシステムの変更についても PAGASA 自身の手で手掛けていく必要がある。

PAGASA は今後、モニタリングネットワークを新規 13 流域へ展開していく予定である。しかし、急激な対象範囲の拡大に加え、PAGASA やドナーの予算・人的資源に限りがあることを考えれば、13 流域でのシステム整備は既設 5 流域とは異なったプロ

セスとなり、システムの整備は段階的に実施し、マルチベンダ環境で整備していく必要がある。

また、13 流域のシステムを効果的に運用していくためには、組織・制度面の強化も必要となる。

- 洪水予警報の運用ルール： 新規 13 流域においても警報基準や運用マニュアルを整備する必要がある。
- PAGASA 及び関係機関の組織強化: 現状 PAGASA では 18 流域をカバーするだけの組織的能力はなく、管轄流域数の増加やシステムの近代化に応じた新規職員の雇用や能力強化が必要である。また、関係機関との緊密な連携も必要である。

洪水予警報対象流域の拡大に向けての提案（アクションのフレームワーク）

12.3 将来必要となるアクションを具体化するため、4 つのカテゴリーによりフレームワークを設定した。カテゴリーA は既存システムの改善・統合、カテゴリーB は新規 13 流域への展開、カテゴリーC は洪水予警報運用のルール作り、カテゴリーD は組織強化と関連機関とのコミュニケーション強化である。

12.4 カテゴリーA は主に、新規 13 流域への展開に必要となる準備作業である。また、カテゴリーC と D は新規 13 流域へのシステム整備の際に、付随して必要となる項目である。各カテゴリーの項目立てを以下に示す。

A. 既存システムの改善・統合
  A.1 地上観測網とリモートモニタリングシステムの組み合わせによる流域の監視
  A.2 既存システムの改変
B. 洪水予警報システムの段階的な新規構築と機器のインターフェイスの標準化
C. 新規流域での洪水警報基準の設定
D. 組織強化と関連機関とのコミュニケーション強化
  D.1 PAGASA HMD の組織強化
  D.2 関連機関との調整強化

12.5 また、これらのアクションを起こす際には、ロードマップの作成が必要である。

[Category A.1] 地上観測網とリモートモニタリングシステムの組み合わせによる流域の監視

12.2 PAGASA HMD は洪水予警報システムによる地上観測網（雨量・水位観測）の範囲を 5 流域から 18 流域に拡大する予定である。加えて、衛星や地上レーダーなどの気象部システムは技術の進展に伴い強化されてきている。両システムは降雨や洪水のモニタリングにおいて重要なシステムである。

12.3 PAGASA 近代化施策の一環として、PAGASA 内に ICT タスクフォースが組織された。同タスクフォースは PAGASA の IT ネットワークの強化を目的として活動している。ICT タスクフォースにより、現在、地上レーダーによる雨量データなど PAGASA 気象部からのアウトプットは WFFC 内及び PRSD にてリアルタイムで閲覧可能となった。ツゲガラオでは、カガヤンリバーセンターと北部ルソン PRSD が同じ建物内にあるため、スタッフは気象部のリモートモニタリングデータと HMD の洪水予警報システムによる地上雨量・水位観測結果を同時に見ることができる。他のリバーセンター

や新規のリバーセンターにおいても、同様の環境を整えるべきである。この文脈から、調査団は以下の提言を行う。

12.4 WFFC とリバーセンターの通信回線の強化

リバーセンターで収集された観測データは WFFC に伝送されるが、このための通信回線強化が必要となる。

- **[A.1.1] ビコール及びカガヤンリバーセンターの通信回線**
  ビコール川、カガヤン川流域に関して、リアルタイムのデータ観測及び収集を実現するため PAGASA HMD 専用回線の構築が必要である。専用回線として既設多重回線のリハビリ、NGCP からの回線リース、電話会社の提供する IP-VPN の利用などが検討対象となる。

- **[A.1.2] FFWS 未整備リバーセンターの通信回線**
  ミンダナオ等、新規 13 流域はマニラから遠方にあり、かつ島嶼に亘ることから衛星回線の利用、IP-VPN による専用回線、NGCP からの回線リース等が検討対象となる。

- **[A.1.3] 既設データ収集系通信回線の改善**
  - パンパンガ及びアグノ系の既設通信回線について保守管理の継続
  - ビコール及びカガヤン系の通信回線リハビリと継続的保守管理
  - 既設 FFWSDO で設置された機器のリハビリ、改善
  - 既設 FFWS 通信回線の二重化
  - 通信回線の整備に於ける最新技術とラニングコストの検討

12.5 PAGASA 気象部門と水文部門の通信ネットワーク統合

PAGASA の気象部門と水文部門の通信ネットワークは現在、切り離されており独立に運用されている。両者を接続して通信ネットワークを統合することにより気象データと水文データの共有化を実現する。

- **[A.1,4] PAGASA 通信ネットワーク統合**
  PAGASA の気象部門と HMD の通信ネットワークの両者を接続することによりリアルタイムにデータ共有が可能となるため、統合化を早期に推進すべきである。

- **[A.1.5] PAGASA ICT セキュリティポリシー**
  システムセキュリティを構築するため PAGASA のセキュリティ方針を策定する。

- **[A.1.6] PAGASA 通信ネットワークの改善**
  - ロードバランサー、コアルーターなどネットワーク内の主要装置は二重化してシステム信頼性を高める。
  - 外部からのネットワーク攻撃に対処するため UTM（統合型脅威管理）システムを導入する。
  - 停電対策として各装置に小規模の交流無停電装置が付加されているがシステム全体としての無停電化を図り電源の信頼性を高める。

12.6　データベースの整備

- **[A.1.7]　HMD** 内モニタリングデータの統合
  PAGASA は PUMIS と呼ばれる統合データベースシステムを整備する予定である。HMD は、モニタリングシステムを PUMIS に接続するため、洪水予警報システムによるモニタリングデータを統合するシステムを整備すべきである。

- **[A.1.8]**　標準データフォーマットの作成
  システム開発業者は各々独自のフォーマットを用いてシステムを作成しているが、通常それらのフォーマットは外部に開示しない。よって、PAGASA は今後のシステム統合に向けて標準データフォーマットを作成するべきである。

12.7　ミンダナオ川流域、アグサン川流域の観測

- **[A.1.9]　GSMaP** と **IFAS** の適用
  ミンダナオ川流域やアグサン川流域のようにセキュリティ上の理由から地上観測網の整備が困難な地域では、リモートモニタリングシステムが有効である。GSMaP は衛星降雨プロダクツの一つであり、IFAS は GSMaP を扱うことのできるインターフェイスを備えた流出解析モデルである。これまでに、カガヤン川流域とパンパンガ川流域を対象として GSMaP と IFAS を用いたトレーニングが実施されている。同様の試みがミンダナオ川流域やアグサン川流域においても必要である。

[Category A.2] 既存システムの改変

- **[A.2.1]**　既存システムの改変
  モニタリングシステムは自然の状況変化に対応して一部改変する必要がある。しかし、現状では一度システムが構築された後に、状況変化に対応してアップデート行うことは難しい状態となっている。例えば、警報基準水位などは適宜変更する必要がある。

[Category B] 洪水予警報システムの段階的な新規構築と機器のインターフェイスの標準化

12.8　新規流域への展開にあたっては段階的なシステム構築が必要である。本調査では整備段階を 3 段階に分けて設定することを提案した。さらに、機器のインターフェイスの標準化も今後の重要なテーマである。

12.9　既存のシステム整備では、限られた数のコントラクターがシステム整備を実施した。しかし、今後の 13 流域でのシステム整備では担当する業者数が増加することが想定され、雨量・水位計整備を担当する業者とテレメータシステム整備を担当する業者が異なることも考えられる。このようなマルチベンダ環境では PAGASA が機器の標準インターフェイスを整備する必要がでてくる。加えて、標準インターフェイスの整備は適正な調達や維持管理・運用の面からも重要である。

- **[B.1]**　洪水予警報システムの段階的整備
  本調査では 3 段階の整備ステージを提案した。レベル 1 では最低限の雨量・水位局整備、LGU との通信回線整備を行う。レベル 2 では雨量・水位局からリバーセンターへのデータ収集系テレメータ回線の整備、及びリバーセンターから

WFFC への通信回線整備を行う。レベル 3 では、洪水・浸水予測モデルの整備、予警報情報の精度向上を目指す。

- **[B.2]** 水位計センサーの適切な選定
  過去のパンパンガ FFWS や ABC システムでは、多くのフロート式とセンシングポール（リードスイッチ式）タイプの水位計が 9 章で述べたように設置されていたが、そのほとんどは耐用年数を過ぎており老朽化していた。設置コストと精度を考慮した結果、2009 年以降 JICA 無償案件事業により、老朽化した水位計の多くは、圧力式に取替えられている。また、その高い精度と 70 m 以上の水深を計測する必要があることから、水晶式水位計はダム貯水池の水位測定用として FFWSDO 案件で設置されている。一方、NOAH プロジェクトや KOICA により、超音波式やレーザー式の水位計が最近設置されるようになった。しかしながら、河川に設置される水位計は、現地の状況から適切な水位計のタイプを選定すべきであり、さらに設置場所は水理・水文学の観点から適切な場所が選定されるべきである。

- **[B.3]** テレメータ機材の標準仕様の確立
  雨量・水位計・データロガーなどの機材の標準仕様を設けることが重要であり、調査団はこれら機材の仕様（案）の概略を以下のように策定した。

  - 水位計は設置場所の状況によりタイプ（フロート、圧力式、超音波など）を定める。水位計の出力信号は 4-20mA とする（全タイプ）。
  - その他の機材仕様案
    - 雨量計信号：パルス
    - 電源仕様：直流 12 V
    - データ通信：VHF/UHF（主）、携帯電話 GSM または衛星（バックアップ）
  - 既設の FFWS と FFWSDO では旧 OECF/JICA 資金であることから、日本国固有の技術基準である BCD 信号が水位計出力とテレメータ装置のインターフェイスとして採用されている。今後は、多くの国で採用されている仕様である 4-20mA 出力信号へとアップデートされるべきである。

[Category C] 新規流域での洪水警報基準の設定

- **[C.1]** 流域ごとの洪水警報基準の設定
  新規流域では、将来的に新しい観測システムに統合されるであろう雨量・水位観測所における警報基準を設定する必要がある。これらの基準は、水文特性、社会経済状況、土地利用、およびレベル 1 の完成に配慮して、流域ごとに検討しなければならない。

- **[C.2]** 新規流域での洪水予警報運用マニュアルの作成
  アグノ川、パンパンガ川流域における観測データの転送・共有に関しては、PAGASA HMD はダム技プロ（2012 年）で更新されたマニュアルを参照し、運用している。このマニュアルに記載された手法を他流域にも適用できるようマニュアルを開発する必要がある。

[Category D.1] PAGASA HMD の組織強化

12.10 今後、新規流域での観測システムが増加するに従い、HMD の作業量は増大すると見られる。従って、新規スタッフの雇用や能力強化による HMD の組織強化が必要不可欠である。近年、HMD は技術的素養を身につけさせるため、短期・長期の研修コースに職員を海外に派遣している。これら能力強化策は、ドナー機関や受け入れ国の調整や財政的支援を受けている。HMD は、洪水予警報関連業務の増加に対応するため、職員の研修参加を積極的に奨励している。組織強化は、PAGASA のもっとも重要な課題の一つであり、以下に掲げる項目は、HMD の業績をより良い方向に導くための手段である。

- **[D.1.1] PAGASA HMD 及び関連機関職員の能力強化**
  PAGASA は、衛星やリモートセンシング情報の有効活用に関する急速な要請拡大に対応するため、2013 年 4 月、「衛星技術適用推進室」を HMD 部長室のもとに設立した。洪水予警報課に所属する 5 名が、この推進室の活動と合わせて 2 つの任務を担い配属されている。一方、PAGASA 内部のみならず NWRB、MWSS、NPC、NIA、DPWH や OCD などの関連機関でも、職員による応用水文学に関する基礎レベルの技術習得への高いニーズがある。この分野では、引続き PAGASA が努力を傾注していく必要がある。能力強化の面からは、職員のトレーニング強化を優先的に推し進めるべきである。

- **[D.1.2] 新規リバーセンター職員の能力強化**
  いくつかの新規流域では、それぞれの流域やプロビンスで新しい職員を雇用する必要がある。その場合、技術面で高い教育を受けた職員の雇用は非常に困難である。従って、基礎的な気象水文学、特に観測及びデータの記録に関する訓練が非常に大事である。事実、HMD では、タクム・リブガノン川のリバーセンターのスタッフとして、ダバオ・デル・ノルテ州の州災害リスク軽減管理評議会から 3 人から 4 人の職員を雇う予定である。リバーセンターによる洪水観測と情報発信による地域サービスを強化するために、HMD の中に、システム的な訓練メカニズムを早急に整えることが重要である。

- **[D.1.3] PAGASA HMD の組織再編**
  HMD 内の洪水予警報業務のためのデータ管理システムは ICT を使って完全、近代化する必要がある。従って、訓練を積んだ ICT 技術者が、PAGASA 内の ICT 改革を実行に移すために緊急に必要である。さらに、水位計や量水票の設置時の地表測量のために、測量技術者が早期に雇用することが望まれる。特に、HMTS 課の人材育成が、特に優先されるべき喫緊の課題である。技術的な素養を持った新しいスタッフの雇用が必要不可欠である。これに関連して、既存の三課、つまり FFWS 課、HMDAS 課、HMTS 課はそのタスクと責任分担の見直し、刷新が求められている。

[Category D.2] 関連機関との調整強化

- **[D.2.1] JOMC の認証と活動**
  1992 年に設立された JOMC は、現在まで、全国レベルで FFWS/ FFWSDO の改善に関する意思決定機関としての役割を果たしている。PAGASA は、ダム技プロ

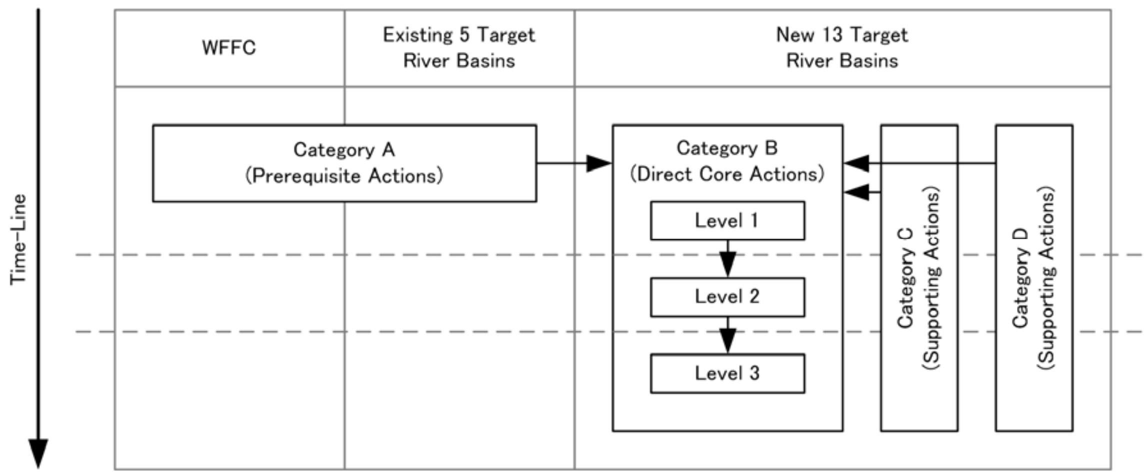
（2012 年）の中で、JOMC 強化計画を策定済みだが、活動を加速させるために計画内容の見直しと更新が必要と考えられる。特に、1992 年に調印された JOMC 設立合意書は、現在の周辺環境やシステムの運用状況を考慮し、十分な見直しが求められる。この新しい合意書は、JOMC の決定事項に拘束力を持たせるため、大統領府（あるいは適切な政府機関や委員会）により公式に承認されることが望ましい。

- **[D.2.2]　リバーセンターと LDRRMC の協力**
  HMD は、現在、「リバーセンター建設プロジェクト」のもと、既設 FFWS の守備範囲をその他の 13 主要流域への拡大を進めている。ミンダナオ島の流域から整備が開始されている。LGU に対し必要とされる洪水情報を適切に伝達するため、リバーセンターと地方災害リスク軽減管理評議会との間の密な連携が重要となる。また、新規流域における洪水予警報システム開発の初期段階では、観測データはケソン市の洪水予警報センターまで転送されないと見られるため留意する必要がある。リバーセンターから発信させる洪水情報は、豪雨や洪水の影響を受けやすい地域住民にとっては非常に重要な情報と言える。

- **[D.2.3]　PAGASA HMD と OCD のデータ回線の改善**
  災害の防御と復旧の観点から PAGASA HMD と OCD 間のコミュニケーションは非常に重要であり、両機関をつなぐデータ回線はリダンダンシーを確保した形でオーバーホールする必要がある。現状の回線は PAGASA HMD から Science Garden と NIA を経由し OCD に接続されており、複雑で脆弱な回線となっている。このため、別途、独立した回線を整備し二重化した回線を用いた運用を行うべきである。

13 流域展開に向けたロードマップの整備

12.11　PAGASA は洪水予警報の対象流域を全国 18 主要流域へ展開する予定であり、既存の 5 流域に加えて新規 13 流域への観測網整備を行う方針である。観測網整備にあたっては、予算と人的資源を考慮したロードマップを作成する必要がある。前述した各カテゴリーについて、大まかなタイムラインを設定すると以下のようなイメージとなるが、今後の詳細な検討が必要である。



Abbreviations（1/6）

A	AC UPS	Alternate CurrentUninterruptible Power Supply	交流無停電装置
	ACIAR	Australian Centre for International Agricultural Research	（組織の名称）
	ADB	Asian Development Bank	アジア開発銀行
	ADCP	Acoustic Doppler Current Profiler	ドップラー流速分布計
	ADPC	Asian Disaster Preparedness Center	（組織の名称）
	APCC	APEC Climate Change Center	（組織の名称）
	ARFFWC	Agno River Flood Forecasting and Warning Center	アグノリバーセンター
	ARG	Automatic Rain Gauge	自動雨量観測局
	ARMM	Autonomous Region in Muslim Mindanao	イスラム教徒ミンダナオ自治地域
	ASEAN	Association of South East Asian Nations	東南アジア諸国連合
	ASTI	Advanced Science and Technology Institute	先端科学技術研究所
	ATSC	Advanced Television System Committee	地上デジタルテレビ北米規格
	AusAID	Australian Government Aid Program	オーストラリア政府援助プログラム
	AWLG	Automatic Water Level Gauge	自動水位観測局
	AWOS	Aviation Weather Observation Station	航空気象観測局
	AWS	Automatic Weather Station	自動気象観測局
B	BDRRMC	Barangay Disaster Risk Reduction and Management Council	バランガイ防災リスク軽減管理評議会
	BDRRMO	Barangay Disaster Risk Reduction and Management Office	バランガイ防災リスク軽減管理事務所
	BRFFWC	Bicol River Flood Forecasting and Warning Center	ビコールリバーセンター
C	CAD	Climatological, Agrometeorology Division	気候、農業気象部
	CBFEWS	Community-Based Flood Early Warning System	コミュニティ早期警報システム
	CBK	Caliraya, Botocan and Kalayaan (hydro plant)	カリラヤ、ボトカン、カラヤン水力発電所
	CCA	Climate Change Adaptation	気候変動対策
	CCAM	Conformal Cubic Atmospheric Model	等角 3 次元大気モデル
	CCC	Climate Change Commission	気候変動委員会
	CD	Capacity Development	キャパシティ・デベロップメント
	CIDA	Canadian Internatinal Development Agency	カナダ国際開発機構
	CIR	Committed Information Rate	認定情報速度
	C/P	Counterpart Personnel	カウンターパート
	CR	Criteria	クライテリア
	CRFFWC	Cagayan River Flood Forecasting and Warning Center	カガヤンリバーセンター
	CSCAND	Collective Strengthening of Community Awareness for Natural Disasters	（ PHIVOLCS, PAGASA, MGB, NAMRIA の総称）
D	DEM	Digital Elevation Model	数値標高モデル
	DENR	Department of Environment and Natural Resources	環境天然資源省
	DHCP	Dynamic Host Configuration Protocol	（IP アドレスを自動割り当てするプロトコルまたは装置）
	DiBEG	Digital Boadcasting Experts Groups	デジタル扶桑技術国際普及部会
	DILG	Department of Interior and Local Government	内務自治省
	DMZ	Demilitarized Zone	非武装地帯 （公開用サーバーを配置するためのネットワーク内の特殊なセグメント）

Abbreviation（2/6）

D	DND	Department of National Defense	国防省
	DNS	Domain Name System	ドメインネームシステム（ドメインネームを IP アドレスに変換する装置）
	DOST	Department of Science and Technology	科学技術省
	DPWH	Department of Public Works and Highways	公共事業道路省
	DRA	Disaster Risk Reduction	災害リスク削減
	DREAM	Disaster Risk Exprosure Assessment for Mitigation	DREAM プロジェクト（Project NOAH コンポーネントのひとつ）
	DRR	Disaster Risk Reduction	災害リスク軽減
	DRRM	Disaster Risk Reduction Management	災害リスク軽減管理
	DSL	Digital Subscriber Line	（電話線を用いて高速データ通信を実現する技術の総称）
	DSWD	Department of Social Welfare and Development	社会福祉省
	DTT	Digital Terrestrial Tlevision	地上デジタルテレビ
	DVB-T	Digital Video Broadcasting - Terrestrial	地上デジタルテレビ欧州規格
E	EFCOS	Effective Flood Control Operation System	洪水制御システム
	FTP	File Transfer Protocol	ファイル転送プロトコル
	ETSD	Engineering and Technical Services Division	エンジニアリング及び技術サービス部
	EWS	Early Warning System	早期警報システム
F	FRM	Flood Risk Management	洪水リスク管理
	FOR	Flood Operation Rule	洪水オペレーションルール
	FWO	Flood Warning Operation	洪水警報業務
G	GA	Government of Australia	オーストラリア政府
	GDP	Gross Domestic Product	国内総生産
	GIS	Geographic Information System	地理情報システム
	GGGI	Global Green Growth Institute	（組織の名称）
	GLOBE	-	（比国の通信会社のひとつ）
	GMMA	Greater Metropolitan Manila Area	大マニラ首都圏
	GNI	Gross National Income	国民総所得
	GoJ	Government of Japan	日本国政府
	GOP	Government of Philippines	フィリピン政府
	GPRS	General Packet Radio Service	GSM のパケットデータ通信
	GPS	Global Positioning System	全地球測位システム
	GSM	Global System for Mobile Communications	（第二世代携帯電話規格のひとつ）
	GSMaP	Global Satellite Mapping of Precipitation	（JAXA 開発の衛星搭載レーダーによる推定雨量データ）
	GTS	Global Telecommunication System	（通信システムのひとつ）
H	HDTV	High Definition Dital TV	高精細テレビ
	HEC-HMS	Hydrologic Engineering Centers Hydrologic Modeling System	（降雨流出解析モデルのひとつ）
	HEC-RAS	Hydrologic Engineering Centers River Analysis System	（河道水理解析モデルのひとつ）
	HMD	Hydrometeorology Division	水文気象部
	HMDAS	Hydrometeorological Data Application Section	データ管理課
	HMTS	Hydrological Telemetry Section	テレメータ機材課

Abbreviation（3/6）

I	ICT	Information and Communications Technology	情報通信技術
	ICHARM	International Center for Water Hazard and Risk Management	水災害・リスクマネジメント国際センター
	IDS	Intrusion Detection System	不正アクセス侵入検知システム
	IEC	Information, Education & Communication	情報、教育、コミュニケーション
	IFAS	Integrtaed Flood Analysis System	統合洪水解析システム
	IHPC	Integrated High Performamce Copmuting	（PAGASA が導入したコンピュータシステムの名称）
	INMARSA	International Maritime Satellite Organization	国際海事衛星機構
	IP	Internet Protocol	インターネットプロトコル（インターネット通信規約）
	IPS	Intrusion Protection System	（不正アクセスを検知してネットワークを保護するシステム）
	IP-VPN	IP Virtual Private Network	仮想私設通信網
	ISDB-T	Integrated Services Digital Broadband-Terrestial	総合デジタル放送サービス（日本のデジタル放送規格）
	ISP	Internet Service Provider	インターネット接続事業者
	IT	Information Technology	情報技術
J	JAMSTEC	Japan Agency for Marine-Earth Science and Technology	（独）海洋研究開発機構（日本国）
	JAXA	Japan Aerospace Exploration Agency	（独）宇宙航空研究機構（日本国）
	JICA	Japan International Cooperation Agency	（独）国際協力機構（日本国）
	JMA	Japan Meteorological Agency	気象庁（日本国）
	JOCV	Japan Overseas Cooperation Volunteers	青年海外協力隊（日本国）
	JOMC	Joint Operation and Management Committee	合同運営管理委員会
K	KICT	Korean Institute of Construction Technology	韓国建設技術研究院
	KOICA	Korea International Coperation Agency	韓国国際協力機構
L	LAN	Local Area Network	ローカル・エリア・ネットワーク
	LGUs	Local Government Units	地方自治体
	LIDAR	Light Intensity Detection and Ranging	（測量装置のひとつ。レーザープロファイラとも呼ばれる。）
	LDRRMC	Local Disaster Risk Reduction and Management Council	ローカル防災リスク軽減管理評議会
	LDRRMF	Local Disaster Risk Reduction and Management Fund	ローカル防災リスク軽減管理予算
	LDRRMO	Local Disaster Risk Reduction and Management Office	ローカル防災リスク軽減管理事務所
	LDRRP	Local Disaster Risk Reduction Plan	ローカル防災リスク軽減計画
	LLDA	Laguna Lake Development Authority	ラグナ湖開発庁
	LMIP	Leyte-Mindanao Interconnection Plan	レイテ・ミンダナオ接続計画
	LTE	Long Term Evolution	（次世代携帯電話規格の名称）
M	MDGF	Millenium Development Goals Fund	ミレニアム開発基金
	MDGs	Millennium Development Goals	ミレニアム開発目標
	MDRRMC	Municipal Disaster Risk Reduction and Management Council	市防災リスク軽減管理評議会
	MDIES	Meteorological Data Information Exchange Section	気象データ情報交換課
	MGB	Mines and Geoscience Bureau	鉱山地球科学局

Abbreviation（4/6）

M	MILF	Moro Islamic Liberation Front	モロ・イスラム解放戦線
	MLIT	Ministry of Land, Infrastructure, Transport and Tourism	国土交通省（日本）
	MIS	Management Information System	（世界銀行調査で提案された情報システム）
	M/M	Minutes of Meeting	議事録
	MMDA	Metropolitan Manila Development Authority	マニラ首都圏開発庁
	MOA	Memorandum of Agreement	合意書
	MOC	Main Operation Center	メインオペレーションセンター
	MOPAS	Korean Ministry of Public Administration and Security	韓国公共安全省
	MPEG-2	Moving Picture Experts Group-2	（映像データ圧縮方式国際規格のひとつ）
M	MPEG-AAC	Moving Picture Experts Group-Advanced Audio Coding	（音声データ圧縮方式国際規格のひとつ）
	MPLS	Multi-Plotocol Label Switch	（ラベルスイッチを用いたネットワーク転送技術）
	MTS	Meteorologiccal Telecommunication System	気象通信網
	MW	Micro-Wave	マイクロ波
	MWSS	Metropolitan Waterworks and Sewerage System	マニラ首都圏上下水道公社
N	NAMRIA	National Mapping and Resources Information Authority	国立地理資源情報庁
	NCR	National Capital Region	首都圏地域
	NDMI	National Disaster Management Institute, Korea	韓国国家災害管理研究所
	NDRRMC	Naitonal Disaster Risk Reduction Management Council	国家災害リスク軽減管理評議会
	NEDA	National Economic and Development Authority	国家経済開発庁
	NGCP	National Grid Corporation of the Philippines	全国送電会社
	NGOs	Non-governmental Organization	非政府系機関
	NHCS	Napindan Hydraulic Control Structures	ナピンダン水利構造物
	NIA	National Irrigation Administration	国家かんがい局
	NMG	Numerical Modelling Group	数値モデルグループ
	NMHSs	National Meteorological and Hydrological Services	国家の水文気象機関
	NMP	Numerical Modeling Physical	数値物理モデル
	NORAD	Norwegian Agency for Development Cooperation	ノルウェー国開発公社
	NOAH	Nationwide Operational Assessment of Hazards	NOAH プロジェクト
	NPC	National Power Corporation	国家電力公社
	NSTP	National Science and Technology Plan	国家科学技術計画
	NTC	National Telecommunication Commission	国家電信電話委員会
	NTP	Network Time Protocol	（ネットワーク内の時間を校正管理するプロトコル）
	NWP	Numerical Weather Prediction	数値気象予報
	NWRB	National Water Resources Board	国家水資源評議会
	NWRMC	National Water Resources Management Council	国家水資源管理委員会
	NWS	Numerical Weather Prediction	数値天気予報
	NZAP	New Zealand Association of Psychotherapists	ニュージーランド心理療法士協会

Abbreviation（5/6）

O	OCD	Office of Civil Defence	市民防衛局
	ODA	Official Development Assistance	政府開発援助
	OECF	Overseas Economic Cooperation Fund of Japan	海外経済協力基金
	OFC	Optic Fiber Cable	光ファイバーケーブル
	OFDM	Orthogonal Frequency Division Multiplexing	直交周波数分割多重方式
	O & M	Operation and Maintenance	運用・維持管理
P	PABC system	Pampanga Agno Bicol Cagayan system	（OECF/JICA により建設された FFWS システム）
	PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration	フィリピン天文気象庁
	PDRRMC	Provincial Disaster Risk Reduction and Management Council	州防災リスク軽減管理評議会
	PHIVOLCS	Philippine Institute of Volcanology and Seismology	フィリピン火山地震研究所
	PHP	Philippine Peso	（フィリピン国通貨）
	PIA	Philippine Information Agency	フィリピン情報局
	PLDT	Philippine Long Distance Telephone	（フィリピン電話会社の名称）
	PREGINET	Philippine Research Education Information Network	フィリピン学術・教育情報ネットワーク
	PRFFWC	Pampanga River Flood Forecasting and Warning Center	パンパンガリバーセンター
	PRSD	PAGASA Regional Services Division	PAGASA 地方気象台
	PSTN	Public Switched Telephone Networks	公衆交換電話網
	PUMIS	PAGASA Unified Meteorological Information System	PAGASA 統合気象情報システム
	PWRSDP	Philippine Water Resources Sector Development Plan	フィリピン水資源セクター開発計画
R	RAP	Risk Assessment Project	RAP プロジェクト
	RA V	Regional Association V	WMO 第 5 地区協会
	RDRRMC	Regional Disaster Risk Reduction and Management Council	リージョン防災リスク軽減管理評議会
	READY	The Hazard Mapping and Assessment for Effective Community-Based Disaster Risk Management Project	READY プロジェクト
	RFFWC	River Flood Forecasting and Warning Center	リバーセンター
	RIMES	Regional Integrated Multi-hazard Early Warning System	（組織の名称）
	RPR	Resilient Packet Ring	レジリエント・パケット・リング（IP ネットワークバックボーンに利用される装置の名称）
	RSD	Regional Service Division	地方気象台
	RTU	Remote Terminal Unit	遠隔端末装置
S	SFN	Single Frequency Network	単一周波数ネットワーク
	SMS	Short Message Service	ショートメッセージサービス
T	TAMSS	Techniques Application and Meteorological Satellite Section	応用技術気象衛星課
	TCP	Technical Cooperation Project	技術協力プロジェクト
	TECO	Taipei Economic and Cultural Office	台湾経済文化事務所

Abbreviation（6/6）

U	UHF	Ultra High Frequency	極超短波周波数帯 (300MHz～3GHz)
	UNDP	United Nations Development Plan	国連開発計画
	UNISDR	United Nations Secretariat for International Strategy for Disaster Reduction	国連国際防災戦略
	UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific	国連アジア太平洋経済社会委員会
	UP	University of the Philippines	フィリピン大学
	UPNIGS	National Institute of Geological Sciences, University of the Philippines	国立地質学研究所（フィリピン大学）
	USAID	United States Agency for International Development	アメリカ合衆国国際開発機構
	USTDA	U.S. Trade and Development Agency	アメリカ合衆国貿易開発機構
	UTM	Unified Threat Management	統合型脅威管理
V	VHF	Very High Frequency	超短波周波数帯 (30MHz～300MHz)
	VM	Virtual Machine	仮想コンピュータ
	VoIP	Voice over IP	ボイプ（インターネット上で音声を伝送する技術）
	VSAT	Very Small Aperture Terminal	超小型地球局
W	WB	World Bank	世界銀行
	WD	Weather Division	気象部
	WDM	Wavelength Division Multiplex	波長分割多重化技術
	WFFC	Weather and Flood Forecasting Center (PAGASA)	気象及び洪水予警報センター（PAGASA）
	WFP	World Food Program, UN	国連世界食糧計画
	WiMAX	Worldwide Interoperability of Microwave Access	（無線通信技術規格のひとつ）
	WIS	WMO Information System	WMO 情報システム
	WLMS	Water Level Monitoring Stations	水位観測局
	WLS	Water Level Sensors	水位センサー
	WMO	World Meteorological Organization	世界気象機関
X	X Band MP Radar	X Band Multi-Parameter Radar	X バンドマルチパラメータレーダー

Exchange rate
USD 1.0=JPY98.7069=PHP43.3570
(Source: Bangko Sentral ng Pilipinas Treasury Department, September 25, 2013)

The Republic of the Philippines

DATA COLLECTION SURVEY
ON
SITUATION OF NATIONWIDE FLOOD FORECASTING AND WARNING SYSTEM

FINAL REPORT

Table of Contents

List of Tables

List of Figures

List of Appendices

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Republic of the Philippines is located between latitude of N 5° and N21° and longitude of E117° and E127° . It consists of approximately 7,100 islands and the archipelago forming the nation is facing to West Philippine Sea/South China Sea at the west, the Pacific Ocean at the east, Sulu and Celebes Seas at the south and Balintang Straits to the north. The national land is approximately 300,000 km^2 (80% of Japan) of which approximately 65% is shared by both the largest, Luzon, and the second largest, Mindanao Islands of the Philippines. The Philippines is one of the countries in the world most vulnerable to natural disaster. It is affected by natural hazards such as typhoon and torrential rainfall, flood, volcanic eruption, earthquake, drought, natural fire, landslide, storm surge and high tide.

The damage due to typhoon and torrential rainfall is significantly large, and around 20 typhoons cross and/or approach annually, bringing about serious damage to lives and properties. Further, increasing flood damage is anticipated in association with climate change, accelerating urbanization, and other factors.

On the other hand, flood forecasting and warning system (FFWS) and flood forecasting and warning system for dam operation (FFWSDO) have been installed as one of the main non-structural countermeasures. It aims to issue early warning and information for evacuation as well as for structural measures in major river basins. Since 1973 when the pilot FFWS was introduced in the Pampanga River basin with the assistance of the Government of Japan, FFWS has been installed in the five river basins, namely, the Pampanga, Agno, Bicol, Cagayan and Pasig-Marikina River basins through various cooperation schemes (Grant-aid, Yen loan, project-type and non-project type technical cooperation). The Department of Science and Technology– Philippine Atmospheric, Geophysical and Astronomical Services Administration (DOST-PAGASA) has consistently performed in the management of the overall system. In the upstream basin and downstream affected areas by dam discharge, management of FFWS/FFWDO is the responsibility of the dam owners such as the National Power Corporation (NPC) and National Irrigation Administration (NIA).

Recently, the importance and necessity of FFWS/FFWDO was recognized through the large-scale flood inundation damage caused by the Typhoons Ondoy/Pepeng in September to October 2009 and the Typhoons Pedring/Sendong in September and December 2011. In order to reinforce the capability of existing FFWS/FFWSDO, foreign donors from developed countries such as Japan, Korea, Taiwan, Australia, Canada and Norway and international donors such as United Nations Development Plan (UNDP) and Asian Development Bank (ADB) have also embarked in projects on flood early warning systems. In conjunction with this, the Government of Japan (GOJ) and Japan International Cooperation Agency (JICA) has continuously extended assistance through enhancement and upgrading of existing FFWS. The UNDP and Australian Government (AusAID) have been implementing the Project:

Multihazard mapping and assessment for effective community-based disaster risk management or the READY Project since 2006 to the present.

Further, the DOST has also initiated the National Operational Assessment of Hazards or NOAH Project[1] in October 2011. The aim is to strengthen monitoring and information sharing of floods and better visualization of flood inundation in major river basins. With the numerous projects or initiatives currently being implemented, the DOST-PAGASA has been facing quite a number of challenges.

Although the outcome resulting from continuous assistance by GOJ and JICA in the past 40 years has gradually and effectively been integrated in the target five river basins, PAGASA is now confronted with the tasks of operating and maintaining new development projects of FFWS under the given circumstances. Therefore, substantial review of the output in past project formulation studies becomes necessary. The needs in the related agencies for capacity development (policy, plan, organization, equipment, technology and finance, etc.) are clearly recognized and the policy/direction for assistance including advanced technology in the field of FFWS should be appropriately decided with consideration of the current situation in the Philippines.

1.2 Objectives of the Study

The objectives of the Study are as follows:

(1) To identify the crucial issues on rapid expansion of work territories in five river basins (Agno, Bicol, Cagayan, Pasig-Marikina and Pampanga) where FFWSs already exist,

(2) To clarify the current conditions and prospects of future development in 13 major river basins (Abra, Abulug, Panay, Jalaur, Ilog-Hilabangan, Agusan, Agus-Lake Lanao, Buayan-Malungon, Cagayana de Oro, Mindanano, Davao, Tagoloan, and Tagum-Libuganon),

(3) To identify the crucial issues in the river basin that do not belong to the major river basin (Mandulog which has been devastated recently), and

(4) To clarify needs on capacity development in the aspects of policy making, planning, organization, equipment, technology, finance, and other concerns in all 19 target river basins.

1.3 Study Area

The Study Area is a total of 19 river basins consisting of three categories as follows:

(1) **Five river basins** being equipped with FFWS

- Luzon Island : Agno, Bicol, Cagayan, Marikina and Pampanga

(2) **13 river basins** not being equipped with FFWS

- Luzon Island : Abra and Abulug

[1] The Project NOAH was initiated by President Aquino's instructions to put in place a responsive program for disaster prevention and mitigation, specially, for the Philippines's warning agencies to be able to provide six hours lead-time warning to vulnerable communities against impending floods and to use advanced technology to enhance current geo-hazard vulnerability maps.

- Visayas : Panay, Jalaur, Ilog-Hilabangan
- Mindanao Island : Agusan, Agus-Lake Lanao, Buayan-Malungon, Cagayan de Oro, Mindanao (Cotabato), Davao, Tagoloan, Tagum-Libuganon

(3) **One river basin** which has been devastated by a recent flood

- Mindanao Island : Mandulog (Iligan City)

1.4 The Final Report

The Final Report was prepared in accordance with the required revisions by PAGASA and new findings and information through the field works conducted by the Study Team in June and from August to September 2013.

The Final Report consists of 12 Chapters, which contained and updated for the all issues presented in the Interim Report in June 2013. The work flow chart at completion stage of the Study in September 2013 is shown in the "Location Map of the Study Areas" of this Final Report.

1.5 Collected Data and Information

The collected data and information in the respective fields are summarized as shown in Table 1.5.1. Throughout the Study, intensive interviews with the personnel concerned were conducted to verify the current status and to collect information for the Study. Table 1.5.2 presents an inventory sheet of the interview survey.

CHAPTER 2 SCHEDULE OF PROJECT ACTIVITIES

2.1 Overall Survey Schedule

The overall work schedule of the Survey from the commencement to the end of the contract specifying the dates of key events/ major works is as follows:

Overall Schedule of Survey Works

Item	YR2013								
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
	1	2	2	2	3			4, 5	
Key Events	Commencement of the Study	Kick-off Meeting (3/12)	Workshop at Tuguegarao (4/11)		Interim Report Submission (6/20)			Discussion on Final Report (Darft Version) (9/13)	Submission of Final Report
Major Works Completed		Data collection & interviews with concerned agencies	Preparation of Interim Report	Preparation of Interim Report	Follow-up survey			Follow-up survey & preparation of Final Report	

Note: 1: 1st Home Work 2: 1st Field Work
5: 2nd Home Wrok 3: 2nd Field Work
4: 3rd Field Work

Source: Study Team

2.2 Chronological Events of Survey Works

The major events of the Survey are tabulated as follows:

Chronological Events of Survey

Date	Major Events	Place
Mar.12, 2013	Kick-off Meeting	• Venue: Amihan Conference Room, PAGASA Central Office, Diliman, Quezon City • Attendees: 45 persons (from total ten agencies)
Apr.11, 2013	Seminar ➢ Objectives • To extract crucial issues/future strategy for elaboration/strengthening of existing FFWS in the Cagayan River basin • To verify crucial issus for expansion of existing FFWS to other river basins (e.g.Davao River basin in Mindanao)	• Venue: Conference Room, Holiday Plaza Hotel, Tuguegarao City, Cagayan • Participants: 65 persons including branch offices of central government, LGUs, local media, etc. • Participatory methodology with SWOT was applied and participants were divided into three groups to facilitate exchange of ideas.
April 26, 2013	Preliminary Meeting on Interim Report (Re: Report contents)	• Main contents and key findings of Interim Report were shared. • Venue: Amihan Conference Room PAGASA Central Office, Diliman, Quezon City • Attendees: 34 persons
May 16, 2013	Discussions on Interim Report with PAGASA-JICA Philippine Office	• Anticipated components of the proposed projects were discussed. • Venue: Meeting space, 2nd FL, WFFC, PAGASA

June 18, 2013	Site inspection of EFCOS (Rosario Master Control Station, etc.)	◆ The latest status with crucial issues of EFCOS were discussed and shared between MMDA and the Study Team.
June 20, 2013	Submission of Interim Report	◆ Interim Report was submitted to JICA Philippine Office after incorporating all comments
June 25, 2013	Meeting with ICT Group of PAGASA	◆ Current status on PAGASA's ICT renovation by ICT Group was discussed and the latest information was shared. ◆ Attendees: 13 persons
September 13, 2013	Discussions on Final Report (Draft Version) with PAGASA- JICA Philippine Office	◆ Meeting was held to discuss the Draft Version of Final Report with key personnel of PAGASA, JICA Philippine Office, and JICA Long-Term Expert, etc. ◆ Venue: Amihan Conference Room, PAGASA Central Office, Diliman, Quezon City ◆ Attendees: 23 persons

Source: Study Team

Detailed records of the seminar, handout material, attendant sheet, and minutes of official meetings are compiled in Appendix A.

2.3 Assignment Schedule of the Consultants

The work period (assignment schedule) of the Consultants is tabulated as follows:

Work Period of the Consultants (Actual)

Name	Position	Work Period	No. of days (man-month)
Mr. Yoshihiro Motoki	Team Leader/ Organization/ Flood Warning	(H) Feb.25 – Mar.02, 2013 (F) Mar.04 – May 17 (F) Jun.12 – Jun.26 (F) Aug.19 – Sep.17 (H) Sep.18 – Sep.27	6 75 15 30 10
Total			(H) 16 (0.53) (F) 120 (4.00)
Mr. Shuji Hirota	Meteorology and Hydrology/ Flood Runoff Model A	(F) Mar.04 – Apr.04	30
Total			(F) 30 (1.00)
Mr. Morihiro Wasa	Meteorology and Hydrology/ Flood Runoff Model B	(H) Feb.25 – Mar.02, 2013 (F) Mar.04 – May 17 (F) Jun.12 – Jun.26 (F) Sep.02 – Sep.17 (H) Sep.24 – Sep.27	6 75 15 16 4
Total			(H) 10 (0.33) (F) 106 (3.53)
Mr. Yasushi Azuma	Equipment Planning and O & M	(H) Feb.25 – Mar.02, 2013 (F) Mar.04 – May 17	6 75

		(F) Jun.17 – Jun.21 (F) Aug.26 – Sep.04	5 10
Total			(H) 6 (0.20) (F) 90 (3.00)
Mr. Yoshiyuki Shinji	Forecasting and Warning System	(H) Apr.01 – Apr.06, 2013 (F) Apr.08 – May 05 (F) Jun.17 – Jun.26 (F) Sep.02 – Sep.17	6 28 10 16
Total			(H) 6 (0.20) (F) 54 (1.80)
Mr. Ahmad Al-Hanbali	GIS/ Inundation Analysis	(F) Mar.25 – May 12 (F) Sep.02 – Sep.17	49 16
Total			(F) 65 (2.17)
Grand Total			(H) 38 (1.26) (F)465 (15.50)

Remarks: (H), Home work in Japan (F), Field work in the Philippines
Source: Study Team

The assignment schedule of the Study Team is shown in Table 2.3.1.

CHAPTER 3 SITUATION OF THE TARGET RIVER BASINS

3.1 Watershed and Administrative Boundaries

The watershed boundaries and administrative boundaries in the current Study, which are used for the enumeration of flood potential areas in each target river basin, were applied based on the concerned documents and drawings as follows:

<u>Watershed boundaries</u> : The Study on the Nationwide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas, March 2008, JICA (worked out on the 1:50,000 maps)

<u>Administrative boundaries</u> : Topographic maps of scale 1:50,000 issued by NAMRIA

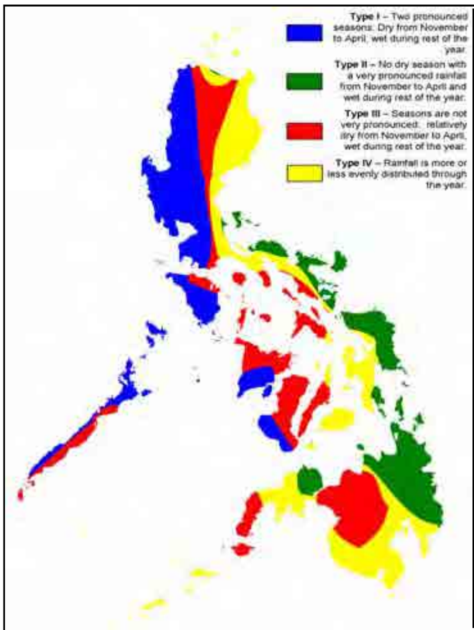
3.2 Meteorology

3.2.1 Rainfall

Rainfall is the most important climatic element in the Philippines. Every year, the frequency of rainfall normally occurs during the Country's wet season. Rainfall during the wet season normally starts in June, which then peaks in July up to September, and decreases in October.

3.2.2 Climate Type

Rainfall distribution throughout the country varies from one region to another. The climate of the Philippines is recognized and categorized into four types. Each climate type is based on the distribution of rainfall that the region/area receives. It also depends on the direction of the moisture-bearing winds and the location of the mountain systems. The following figure shows the climate map of the Philippines.



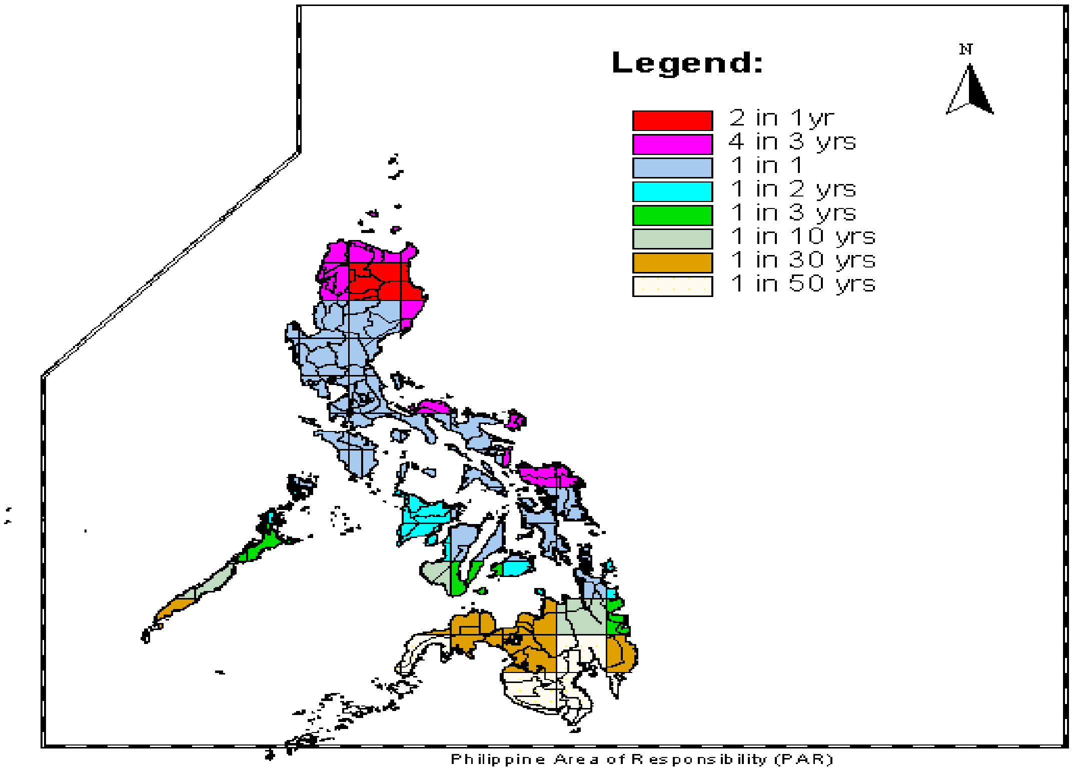
Climate Type	Description
Type I	There are two pronounced seasons: dry from November to April and wet for the rest of the year. The maximum rain period occurs from June to September.
Type II	No dry season with a very pronounced maximum rain period from December to February. There is no single dry month. The minimum monthly rainfall period occurs from March to May.
Type III	No very pronounced maximum rain period. Dry season lasts only from one to three months, either during December to February or March to May. May resemble Climate Type I due to the short dry season.
Type IV	Rainfall is more or less evenly distributed throughout the year. May resemble Climate Type II since it has no dry season.

Source: PAGASA

Climate Map of the Philippines

3.2.3 Tropical Cyclone Frequency

The Philippines, due to its geographical setting, is situated in a region were the most number of tropical cyclones are formed than anywhere in the world. Approximately 20 tropical typhoons pass by or develop inside the Philippine Area of Responsibility each year. The figure below shows the frequency of tropical cyclones in the Philippines from 1948-2005.



Source: Climate Data Section, Climatology and Agrometeology Branch, DOST, PAGASA

Frequency of Tropical Cyclones in the Philippines (1948-2005).

3.3 Flood Potential Areas

To identify flood potential areas, existing inundation analysis outputs were mainly collected from the MGB flood geo-hazard map, and the JICA-FRIMP Study Project. The MGB flood potential map covered 15 river basins out of 19 target river basins. The four river basins that were not covered are Bicol, Tagum-Libuganon, Davao, and Buayan-Malungon. The JICA-FRIMP Project covered all the 19 target river basins; however, some river basins such as Agno, Pampanga, Pasig-Laguna, and Agusan were only partly covered. Therefore, information from the other studies is necessary to cover the entire river basins. For the Pampanga River Basin, the flood potential area identified in the former JICA TCP (2012) was used, as this was carried out recently with detailed inundation analysis. For the Pasig-Laguna de Bay, the flood potential area identified by the READY Project was used as it covered whole basin. Detailed description on flood potential area of the 19 target river basins are shown in Appendix B.

Further, flood damage reports were enumerated based on the statistical records of NWRMC from 1970 to 2012 as compiled in Appendix C.

CHAPTER 4 RELEVANT GOVERNMENT POLICY, LAW, REGULATIONS, AND DEVELOPMENT PLANS

4.1 Philippine Development Plan 2011 - 2016

(1) Scale of damage due to flood disasters to national economy

The issue of climate change and its corresponding effect of risk from natural disasters are acknowledged by the Philippine Development Plan 2011 – 2016 as amplifying the association between poverty and environmental degradation. Natural disasters and calamities can nullify hard-won gains by damaging physical infrastructure, directly endangering human lives and health, and destroying livelihoods, particularly among the poor and vulnerable. Disasters have derailed social and economic development as reported by a World Bank 2005 Study. The Philippines suffered the loss of an average of PhP15 billion annually in direct damages, or more than 0.5 percent of GDP. The indirect and secondary impact of disasters has further increased this cost.

In response to the phenomenon of disasters and extreme events, the Country passed a major legislation: Philippine Disaster Risk Reduction and Management Act of 2010 or RA 10121. The National Disaster Risk Reduction and Management Council (NDRRMC) has been given the mandate to craft and implement the National DRRM Framework and Plan which utilizes the multi-hazard approach in managing the impact of natural and human-induced disasters. Flood Forecasting and Warning Systems (FFWS) play a critical role in enhancing disaster-preparedness and response capabilities so as to build the disaster resilience of communities.

(2) New financial arrangement for disaster risk reduction

To ensure the implementation of the Act, the Government allocates specific amounts annually (PhP5 billion in 2011) for the calamity fund. It is usable in aid, relief and rehabilitation services to affected communities or areas with a special provision allowing its use for pre-disaster activities. On the other hand, Section 22 of the Philippine DRRM Act of 2010 (RA 10121) also enumerates permissible uses of the annual calamity fund, generally allowing support for a wider range of activities (Ref: Section 4.2 for details).

(3) Strategic framework related to FFWS

Consistent with Philippine Agenda 21, the Strategic Framework highlights within the set goals and strategies, provisions for direct or indirect support to the FFWS as a nonstructural component of disaster prevention, as follows:

- Enhance national and local capacities for monitoring, forecasting, hazard identification, early warning, and risk evaluation and management;
- Conduct geo hazard mapping, vulnerability and risk assessments especially for highly susceptible communities and areas for the formulation and implementation of disaster risk reduction and management plans;
- Use science-based tools and technologies to support decisions in identifying, preventing and mitigating potential disaster impacts; collect and disseminate data according to risk

knowledge needs and develop information systems to support decision makers and apprise stakeholders;

- Raise public awareness on DRR and mitigating the impacts of natural disasters through the formulation and implementation of a communication plan for DRR and CCA; and
- Enhance disaster-preparedness through multi-stakeholder coordination and partnership with the business sector in DRR and CCA.

To further enhance and actualize the goals and objectives set, major recommendations for the pursuit and passage of several pieces of priority legislation were presented in the Philippine Development Plan. Number 17 in the list is the PAGASA Modernization Law. It stated that funds will be allocated for the needed reforms of the Agency. Thus, this promises the prospect of generating support for one of the priority projects of PAGASA which is the establishment of FFWS in major river basins of the Philippines.

4.2 Republic Act No. 10121

(1) Rationale

The "Philippine Disaster Risk Reduction and Management Act of 2010", also referred to as the Republic Act No. 10121, was approved by the Senate and the House of Representatives of the Philippines on 27 May 2010. It aims to lessen the adverse impacts of hazards and the possibility of disasters through the systematic process of using administrative directives, organizations, and operational skills and capabilities to implement strategies, policies, and improved coping mechanisms. Also included are good governance, risk assessment and early warning, knowledge and awareness raising, reducing underlying risk factors, and preparedness for effective response and early recovery.

(2) Demarcation of roles by the central government agencies concerned

The National Disaster Risk Reduction and Management Council (NDRRMC) is empowered with policy-making, coordination, integration, supervision, monitoring and evaluation functions. It is headed by the Secretary of the Department of National Defense (DND) as Chairperson with the support of the Vice Chairpersons, Secretaries/Heads of their respective agencies: Department of Interior and Local Government (DILG) for disaster preparedness; Department of Social Welfare and Development (DSWD) for disaster response; Department of Science and Technology (DOST) for disaster prevention and mitigation; and the National Economic and Development (NEDA) for disaster rehabilitation and recovery.

The DND's Office of Civil Defense (OCD) Administrator serves as the Executive Director of the National Council with the primary mission of administering a comprehensive national civil defense and disaster risk reduction and management program. Among its various functions is the establishment of standard operating procedures on the communication system among provincial, city, municipal, and barangay disaster risk reduction and management councils. This is mainly for purposes of warning and alerting them and of gathering information on the affected areas before, during, and after disasters.

(3) Improvement of financial support for implementation of LDRRPs

In order to generate the smooth implementation flow of the provisions stipulated in Republic Act No. 10121, the Local Disaster Risk Reduction and Management Fund (LDRRMF) replaces the Local Calamity Fund. Not less than the five percent (5%) of the estimated revenue from regular sources shall be set aside to support disaster risk management activities. The budget is integrated into the local development and annual work and financial plan. At a broader level, the National Disaster Risk Reduction and Management Fund (NDRRM Fund) shall be used for disaster and preparedness activities such as, but not limited to, training of personnel, procurement of equipment, and capital expenditures. In particular, 30% of LDRRM Fund is generally allocated as Quick Response Fund (QRF) or stand-by fund for relief and recovery programs and the rest 70% is utilized for other disaster management activities. The LDRRMF is utilized for implementation of LDRRMPs.

(4) Tasks of NDRRMC and LDRRMOs

Among the tasks and functions of the NDRRMC is the establishment of a national early warning and emergency alert system. This consists of a set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to prevent the possibility of harm or loss.

Therefore it is critical that all the various levels of government are involved in the performance of functions necessary for the effective operations and implementation of the Act. The RDRRMC or the Regional Disaster Risk Reduction and Management Council ensure disaster sensitive regional development plans as implemented by operations centers. Activities are supported by the provincial, municipal, and barangay organizations at the local level through their respective Local Disaster Risk Reduction and Management Office (LDRRMO) and the Barangay Disaster Risk Reduction and Management Office (BDRRMO).

Among the major responsibilities of the former is to operate a multi-hazard early warning system linked to disaster risk reduction to provide accurate and timely advice to national and local emergency response organizations and to the general public, through diverse mass media, particularly radio, landline communications, and technologies of communication with rural communities. In effect, there is a need to disseminate information and raise public awareness about hazards, vulnerabilities and risks, their nature, effects, early warning signs and counter measures.

4.3 Status, Challenges and Proposed National Water Resources Management Council (NWRMC) for Philippine Water Resources Sector Development Plan[1]

The Philippine Water Resources Sector Development Plan (PWRSDP) has recently been developed in response to the need for a stronger and more efficient water resources management in the Country. The PWRSDP called for the development of the National Water Resources Management Council (NWRMC) invoking the provisions of PD 424 (1974 law

[1] Sources of Information: Individual Action Plan Update for the Philippines for 2012: Philippine Water Resources Sector Development Plan; MDG-F 1919 Integrated Policy Paper for Pro-poor Water Supply and Sanitation, January 2012.

creating the National Water Resources Council to coordinate and integrate water resources development under the DPWH) and PD 1067 (1976 Water Code of the Philippines).

There has been an assessment and framework planning of the Water Resources Sector as part of the Philippine Water Supply Sector Roadmap and in preparation for the passage of the draft Water Regulatory Commission Bill.

The NWRMC will be the water sector apex body tasked to manage and protect the Country's water resources for all its different and competing uses. The NWRMC will absorb the National Water Resources Board (NWRB) and other water resources related functions of other agencies. In some cases, the NWRMC may opt to partner or subcontract certain functions to some related agencies but remain ultimately responsible for ensuring effective, efficient and sustainable water resources management. The NWRMC will have a governing body headed by the President, an Inter-agency and Multi-stakeholder Advisory Panel and the Executive body responsible for its day to day operations.

Major Functions/Working Divisions of the NWRMC consist of:

(1) Planning and Policy Studies
(2) Data Collection and Monitoring
(3) Scientific and Decision Support Systems
(4) Infrastructure and Program Development
(5) Strategic Development of Water Facilities and Operations
(6) Regulatory Functions: both for economic and resource regulation including extraction and water permits, quantity, quality, monitoring and enforcement, and conflict resolution
(7) Water Economics Studies
(8) Public Relations and Capacity Development
(9) River Basin Organization Development

NEDA and the DPWH, as co-chairs of the Infrastructure Committee of the National Government, are spearheading the preparation of the Operational Plan and institutional arrangements of the NWRMC. The DPWH, by virtue of Executive Order No. 62 issued in October 2011, has been mandated by the President to submit the implementing rules and regulations related to the NWRMC. Leading to the full operationalization and implementation of the NWRMC, action plans are being created for the National Water Resources Board (NWRB) to carry out the recommended *"light handed regulations"* in the interim.

Although the status of the implementing rules and regulations related to the NWRMC will be further examined, PAGASA still has continued his mandate of flood forecasting and warning operation as the sole responsible agency at the time of the Final Report in September 2013. The recent interviews with some key staff of PAGASA as well as management direction of the national Project NOAH can support such view.

4.4 Country Assessment Report for the Philippines, "Strengthening of Hydro Meteorological Services in Southeast Asia", 2013[2]

The frequent occurrence and increasing severity of extreme weather and climate events have created serious impacts in various sectors. The National Meteorological and Hydrological Services (NMHSs) of PAGASA, then, faces the challenge of providing more accurate, timely and useful forecasts, products and information. To address this demand, the following basic requirements need to be put in place: 1) adequate networks to monitor hydro meteorological parameters; 2) robust communication system of data transmission, dissemination or forecasts and sharing of information; 3) high speed computing system of data assimilation and numerical; 4) adequately-trained human resource; and 5) more interface approach with users of weather and climate information.

Currently, the need for accurate and more frequent updates on severe weather bulletins for tropical cyclones is being addressed by PAGASA through its automation program. In addition, short-term rainfall forecast for flash flood prone areas is sought by emergency for timely evacuation of threatened communities. This will be addressed upon the completion of the radar program being implemented by the Agency. Moreover, the provision of tailor-made forecast for individual sectors has already started in the agricultural sector with the provision of farm-weather forecasts, climate outlooks, and related services. PAGASA is also making efforts to pursue commercialization of some of its specialized products to companies and other organizations in the private sector (e.g., aviation and shipping, among others). PAGASA has been able to acquire secure monitoring and observation sites through cooperation with private telecommunication companies such as SMART, GLOBE, and SUN CELLULAR.

The PAGASA is the duly mandated agency to operate 98% of all hydro-meteorological observation networks in the Country. It issues all official forecasts, warnings, advisories, outlooks, and press releases on severe weather and extreme events such as tropical cyclones, floods, droughts/dry spell, and El Niño/La Niña. The Agency has updated its strategic plan to address development needs in line with the WMO Regional Association V (RA V) Strategic Plan 2012 – 2015. In addition, PAGASA Onwards 2020 (Long-term Plan) and R and D – Operations and Services Framework were set up and the Agency's investment portfolio is regularly updated. All proposed programs are in consonance with the National Science and Technology Plan (NSTP).

As of December 2011, the PAGASA has a total of 873 staff, majority being in Operations and Services. Other personnel provide Administrative Support, Research Services, and Education and Training. There are 11 PhDs, 50 with MSc, four with Diploma in Meteorology, one in Space Science, and 16 with postgraduate units. The Rationalization Program of PAGASA was approved in October 2008 and is currently being implemented to bring PAGASA's services to the countryside through the establishment of five Regional Service Divisions.

The production and dissemination of hydro meteorological forecasting and warning services

[2] A draft version of this paper was prepared in April 2012 and then updated and finalized in 2013 by the United Nations Secretariat for International Strategy of Disaster Reduction (UNISDR).

are generally fair since most of the observations are still done manually and data integration and processing need to be undertaken. On-line observations are mostly in Luzon and very limited in the Visayas and Mindanao. The quality of information is also fair due to limited automatic editing and production system. The PAGASA does not issue quantitative short-term forecasts or nowcasts (A power tool in warning the public of hazardous, high-impact weather incidents such as flashfloods, lightning strikes and destructive winds) due to lack of appropriate equipment and inadequate skills of the technical personnel in the field.

PAGASA is implementing a modernization program, the salient features of which are: 1) development of a three year modernization plan; 2) acquisition of additional needed state-of-the-art equipment and instruments, machines, computers and other facilities to improve capabilities; 3) manpower training and human resources development; 4) strengthening of Regional Weather Service Centers at strategic areas in the Country; and 5) cultivation of greater awareness by the public of the weather system through educational projects and programs.

The trans-boundary nature of weather-causing phenomena would require regional cooperation and data sharing collaboration being currently undertaken by the World Meteorological Organization (WMO) through its WMO Information System (WIS). In 2005, the PAGASA made a commitment in line with the "Hyogo Framework for Action 2005-2012: Building the Resilience of Nations and Communities for Disasters" to pursue the overall goal of protecting lives and property from future hazards and disasters.

The Agency also actively participates in regional and international collaborative undertakings for knowledge sharing and capacity building. A designated WMO Regional Training Center for South Pacific, it is involved in activities with various UN organizations and other groups such as the APEC Climate Change Center (APCC) and the Regional Integrated Multi-hazard Early Warning System (RIMES). Some countries engaged in collaborative efforts with PAGASA are the following: Japan, Korea, Vietnam, Mongolia, and Germany. PAGASA is supported by the national government, the private sector and various foreign donors from Japan (JICA). Korea (KOICA), Taiwan (TECO), Australia (AusAID, ACIAR. GA, BoM), Spain, Norway (NORAD), and the USA (USTDA, USAID). Other inputs are provided by the United Nations (UNDP), the World Bank. and Asian Disaster Preparedness Center (ADPC).

The modernization of PAGASA covers the ongoing projects on flood forecasting, radar, wind profiler, marine buoy, AWOS, AWS, High speed PC cluster computing system, and specialized training of personnel in hydro meteorology and related fields. The last is considered a critical component of the modernization program since it involves strengthening of cooperation among NMHS in Southeast Asia for data sharing exchange of related information and research collaboration.

The proposed Project which complements the modernization plan will seek the support of foreign donors with counterpart funds and technical personnel from the National Government. The Philippine Government has funded the establishment of nine new Doppler radars and other observing equipment that are expected to be operational in 2016. Further, funds will be allocated as consequential expenses for the operation and maintenance of new equipment to be procured under this Project in support of regional cooperation in Southeast Asia.

This report eventually suggests following gaps and needs in current operation of PAGASA:

(1) Data products

- Data rescue of historical climate data is urgently needed.
- High performance Data Quality Management system to support NWP (numerical weather prediction) system
- Integrated database system for NWP data assimilation
- Replacement and timely calibration schedule of met. and climate instruments in some remote stations
- Reliable and low-cost observation data communication system needed for efficiency

(2) Hazard analysis to support risk assessment

- Sufficient number of experts in disaster mitigation and risk assessment
- Applied R & D products for domestic weather and climate forecasting still relatively limited

(3) Forecasts and warnings

- High performance NMP assimilation system in place and operational
- Radar and satellite data assimilation and remote sensing based observation product development
- Development of human resources in weather and climate modeling (NWP) and climate models)
- Flood forecasts showing height and limits of inundation areas
- Extended hydrological forecasts
- Tailor made forecasts for various sectors

Aside from shortage of number of experts for hazard analysis and risk assessment as noted by UNISDR's report above, the Hydrometeorological Division (HMD) of PAGASA faces the challenge of maintaining the quality of services due to insufficient staff to handle routine works in all four sections. In particular, in addition to the regular services, HMD is conducting 17 donor's projects/studies in parallel. In order to successfully accomplish those tasks, institutional strengthening of HMD and capacity development of the HMD staff is one of keen issues for PAGASA.

4.5 Mindanao Declaration on Disaster Risk Reduction Priorities[3]

(1) Mindanao Summit on DRR and Geo-Hazard

Right after the serious devastation due to typhoon Sendong in December 2011, two-day

3 Information based on http://www.preventionweb.net/english/policies/v.php?id=25214&cid=135

Mindanao Summit on Disaster Risk Reduction and Geo-hazard Awareness was conducted at Cagayan de Oro, Misamis Oriental, on February 18 and 19, 2012. Through the summit, the three-page "Mindanao Declaration on Disaster Risk Reduction Priorities" was prepared and approved by consensus.

The summit was convened to discuss and learn lessons from the Sendong tragedy by two senators in Mindanao. The issues tackled were the Philippine Disaster Risk Reduction and Management Action Plan, the Philippine Climate Change Action Plan, Typhoon Sendong: A scientific explanation on what happened, the state of disaster preparedness in Mindanao, Geo-hazard zones in Mindanao, water use challenges, and civil society participation. The summit gathered some 300 participants from government and civil society on the first day and about half that number on the second day.

(2) "Mindanao Declaration on Disaster Risk Reduction Priorities"

The Declaration seeks the adoption and implementation of DRRM plans at the regional, provincial, municipal and Brangay levels based on "good and updated, lacation-specific, scientific knowledge and analysis, including risk assessment and consciousness of adaptive capacity, and aiming at zero-casualty and minimal economic damage."

The three-page, 28-paragraph "Mindanao Declaration on Disaster Risk Reduction Priorities" drafted from the regional workshop results and approved by consensus, listed eight priorities: Knowledge, Emergency, Preparedness, and Response, DRRM Plans, Enforcement of Laws, Ecosystem-based Approach, National Legislation, Institutional Mechanism, and Implementation.

(3) Recommendations

Under emergency preparedness and response, the Declaration seeks to address the needs of vulnerable and exposed communities including "building adequate and permanent evacuation centers so that public schools, buildings, and grounds are not regularly disrupted as a result of disaster."

It also proposes the relocation of communities in danger zone to "safe and accessible places" and the provision of emergency kits for indivuals and families, conducting regular drills to prepare for disasters; simplifying disaster response protocols; and organizing effective psychosocial interventions to help affected persons and families to cope and adapt.

Under national legislation, the Department recommends the passage of pending bills such the People's Survival Fund, People's Solidarity Find, the Land Use Act, and "laws that will establish a permanent, independent disaster management and risk reduction agency and promote inter-local government cooperation in DRR – CCA (Disaster Risk Reduction – Climate Change Adaptation).

It is judged that PAGASA's current activities of "River Center Project" in Mindanao will connect closely with the aims seeking by the Declaration. In particular, earlier installation of FFWS in the vulnerable areas to floods in Mindanao can contribute in disaster risk reduction.

4.6 Master Plan for Flood Management in Metro Manila and Surrounding Areas (Final Draft Master Plan Report), March 2012, the World Bank

In September 2009, Tropical Storm Ondoy hit Metro Manila and surrounding areas, and caused tremendous flood damages. The objectives of the Study are to establish the vision, which will be the blueprint or road map, for a sustainable and effective flood risk management (FRM) in Metro Manila and Surrounding Areas.

The proposed projects in the Study are structural mitigation measures, non-structural mitigation measures, and preparedness measures. The four preparedness measures are related to the tasks of PAGASA:

1) Improvement of EFCOS: Very High Priority

Improvement of the EFCOS is proposed, which includes improvement of the equipments, data transfer stations to PAGASA for their utilization for flood forecasting and warning as well as for the related agencies and LGUs, and some additional monitoring stations. As the monitoring data by EFCOS is important for operation of the flood control facilities such as the Rosario Weir of Mangahan Floodway and the drainage pumping stations along the Pasig River as well as important for FRM in the Pasig-Marikina River Basin, it is recommended to improve EFCOS with very high priority. The estimated cost for improvement of EFCOS is 400 million Pesos.

2) Installing New Telemetric Rainfall and Water Level Gauging Stations as well as Radar Rainfall Gauge for PAGASA: Very High Priority

The monitoring system for rainfall and water level in the Malabon-Tullahan River Basin, Meycauayan River Basin, South Parañaque – Las Piñas River Basin and Laguna Lake Basin is very much insufficient in the present. Therefore, improvement of the monitoring system is proposed. This improvement includes new telemetric rainfall and water level gauging stations and radar rain gauge as well as data transfer station.

This improvement is to be conducted with very high priority. The estimated cost for the improvement is 685 million Pesos.

3) Capacity Building for Strengthening Community-based Flood Risk Management: Very High Priority

Community-based FRM is very important, because final decision for flood warning and evacuation is under the responsibility of BDRRMC or BDC and the people in barangays themselves. Not only for emergency response and relief, but also for mitigation, preparedness and rehabilitation, community-based FRM can contribute very much. Therefore, concept for strengthening the community-based FRM from the aspects of mitigation, preparedness, response and rehabilitation under people’s participatory approach is proposed in this study.

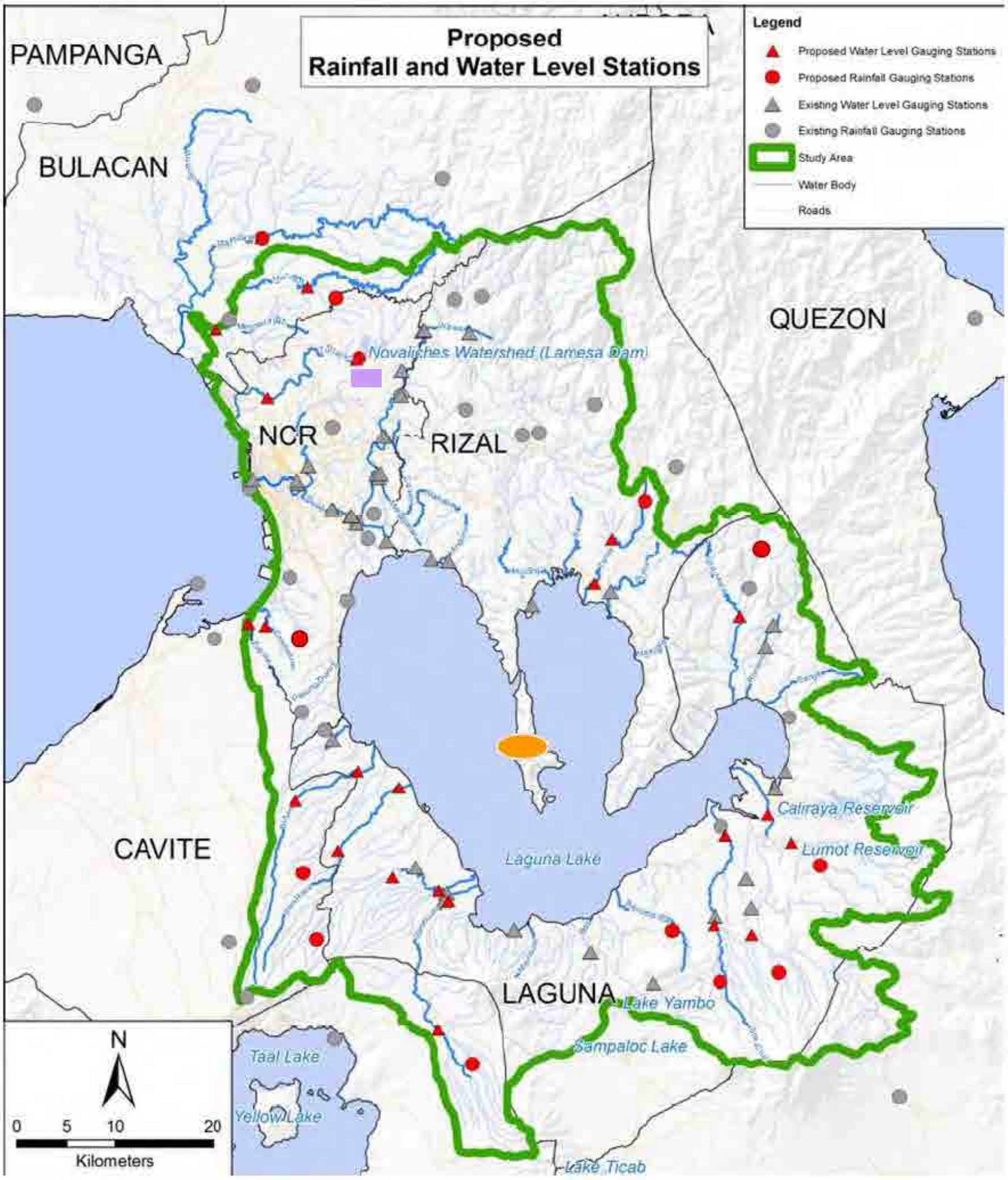
Furthermore, in order to find the best way for strengthening the community-based FRM, and to make good example, it is recommended to conduct a pilot project including several communities (barangays).

4) Improvement of Management Information System (MIS) for Disaster Risk Management: High Priority

Management Information System for DRRM is very important to grasp and share the necessary information on the occurrence of disaster and also the matter of DRRM between the agencies and LGUs related to DRRM. Together with the conventional method of communication by telephone and facsimile, improvement of MIS by introducing intranet and long distance two-way radio system as well as utilization of GIS are proposed in this Study as one of the concepts for improving the MIS for DRRM with high priority. It is recommended to conduct a detailed study on the improvement of MIS for DRRM in the country first.

The location map of the proposed telemetric rainfall and water level gauges and rainfall radars is shown in next page. There is no detail description of rainfall radar in the Study, however the proposed sites for new rainfall radars seems to be the Lamesa Dam and the Talim Island.

According to the interview survey, PAGASA HMD intends to install X-band MP radar in the Talim Island in reaction to the proposal from the World Bank.



Source: Master Plan for Flood Management in Metro Manila and Surrounding Areas (Final Draft Master Plan Report), March 2012, the World Bank

Proposed Telemetry Monitoring System with Radar Rain Gauge in Laguna Lake basin

CHAPTER 5 COUNTRY DEVELOPMENT POLICY AND AID PROGRAM OF THE GOVERNMENT OF JAPAN

5.1 Country Assistance Program for the Philippines (June 2008)

5.1.1 Background

The 1st Assistance Program for the Philippines was contemplated in 2000. Then it was decided that a revision be made mainly due to the change of economic status of the Philippines and the announcement of the Medium Term Philippine Development Plan (MTPDP) by President Arroyo's Administration in 2004. Based on the recognition of the importance of a new program to cope with the changed situation, the Country Assistance Program was issued in June 2008 showing the general direction of the Official Development Assistance to the Philippines for the incoming five years. Through a substantial review of the achievement of the priority issues in the 1st Assistance Program in 2000, the new program was prepared.

5.1.2 Rationale of Assistance to the Philippines

The Program cited the importance of extending assistance to the Philippines, as follows:

(1) The Philippines is located at a strategic point along marine transport and is an important Country in terms of geographic and regional security.

(2) The Philippines has the same sense of values as Japan with reference to liberal democracy, fundamental human rights, and market-oriented economy, etc. and thus is an important partner for diplomacy in Southeast Asia.

(3) A close relationship has been sustained between Japan and the Philippines for a long period of time (Both governments signed on the "Agreement between Japan and the Republic of the Philippines for an Economic Partnership" in September 2006.).

5.1.3 Basic Strategy and Direction

In the course of the review of the 1st Assistance Program, seven issues and lessons were identified. Among them, it is noteworthy that the Program in 2008 clearly pointed out the importance of the "Policy-assisted and Task-oriented assistance." It declared that a great deal of thought has to be given to the Policy-assisted assistance in order to assure sustainable effectiveness of the assistance in the Philippine side. Also, to consider the Task-oriented assistance to conduct centralized assistance by means of utilization of all schemes and cross-cutting efforts among sectors for certain selected issues.

5.1.4 Priority Issues for Assistance

After the analysis and evaluation of the previous program and present conditions of the Philippines, the direction of the assistance was decided and the priority issues were selected as follows:

(1) Sustainable economic growth toward creation of job opportunities,
(2) Assistance for self-reliance of the poor people and improvement of life environment, and
(3) Securing peace and order in Mindanao.

Regarding the flood protection and disaster management, its direction and importance are clearly mentioned in connection with the enhancement of basic social services (protection of human lives against natural disasters) under the above item (2) among the priority issues.

Furthermore, particular attention on the development in Mindanao is given in the Program. It recommended continuous support to be extended to the other regions out of the ARMM areas, including former disputed areas with MILF. It also targeted the improvement of socio-economic conditions in the entire Mindanao Island.

5.2 Country Assistance Policy for the Philippines (April 2012)

5.2.1 Rationale of Assistance

The backbone of this policy paper succeeded the previous "Country Assistance Program for the Philippines (June 2008)." The new Policy Paper pointed out that the rationale of assistance by Japan is based on the recognition that both countries are important partners in East Asia referring to the recent trend in the region. In 2011, it was confirmed that the relationship between the two countries has grown to become a "Strategic Partnership". Both have kept a close economic relationship as well as a fundamental basis of broad human interchange. And now, there is a possibility that a complementary cooperative relationship between the two societies would further develop. There being the situation of less children and aging people in the advanced Country of Japan and a large young population in the Philippines.

The GNI (Global National Income) of the Philippines has reached USD 2,050 per capita and the achievements in various fields, except primary education and maternity health, are expected to catch up with the Millennium Development Goals (MDGs). As a whole, the Philippines is now in the stage to target entering into the intermediate developed nations. Japan has extended assistance to the Philippines as top donor for long time. The accumulating diplomatic assets composed of the presence of Japan, various international cooperation, and favorable relationship in the private sector, etc. should be further developed.

5.2.2 Basic Policy of Assistance (Overall Goal)

In order to strengthen "Strategic Partnership," economic cooperation for realization of "Inclusive Growth,"[1] targeted in the "Philippine Development Plan (2011- 2016)," is to be further enhanced.

[1] "Inclusive Growth," means sustainable economic growth with substantial growth speed which can return profits to a wide range of citizens and realize creation of job opportunities and continuous poverty reduction. In the Philippine Development Plan 2011-2016, blocking factors for the "Inclusive Growth" are pointed, (1) lack of infrastructures due to insufficient investment, (2) failure in governance, (3) low industrial competitiveness, (4) low standard human development, and (5) insufficient activities in environmental issues and utilization of resources.

5.2.3 Priority Fields (Intermediate Goals)

The rolling plan for disaster risk reduction and management, which is presented in the Policy Paper, consists of candidate projects of both structural and non-structural measures. Further, since the Philippines is susceptible to climate change, "Assistance for Climate Change Adaptation (CCA)" is considered as a cross cutting issue. Therefore, the projects for disaster risk reduction and management are classified into the "Assistance for CCA" as well.

The following three fields are specified with high priority:

(1) Sustainable economic growth through promotion of investment
(2) Overcome vulnerability and stabilization of fundamentals of life and production
(3) Restoration of peace and development in Mindanao

The development of FFWS/FFWSDO is closely related to Item (2) above and can firmly contribute to the intermediate goal. Under the Item (2), as one of detailed objectives (Development Issues) - "Disaster risk mitigation and management"- total 19 projects/ programs in various schemes such as grant, loan, technical cooperation, dispatching individual experts, grass-roots TCP, etc. are listed.

Further, the policy paper called keen attention on the assistance for the development of Mindanao (affected areas in dispute) after consolidating agreement on peace between the Government of the Philippines and the Moro Islamic Liberation Front (MILF). It stresses on keeping safety with substantial care in proceeding with associated aid activities. In connection with the restoration of peace and order situation of the dispute areas in Mindanao, the people of "Bangsamoro" is now focused on their harmonized development.

In between two consecutive Country Assistance Programs prepared in 2008 and 2012, basic policies in bilateral relationship between two countries in both programs have been unchanged with consistency. It is expected that the administration of the President Aquino will be able to accelerate development of Mindanao on the basis of stable politic situation and firm growth in national economy. No drastic changes and/or particular new interference factor can be seen.

However, it should be noted that ensuring sustainability of FFWS/ FFWSDO in the target river basins in Mindanao needs due consideration on security situation throughout the planning to O & M stages.

5.3 Program Formulation Survey Conducted by JICA (March 2008)

The Government of Japan has prepared the "Country Assistance Program for the Philippines (June 2008) (Draft)" based on the issues raised in the "Medium-Term Philippine Development Plan 2004 – 2010." In the Program, it was decided that "Disaster management program" should be one of the priority issues of "assistance for self-reliance of the poor people and improvement of their living environment." In the Philippines, it was presumed that the importance of disaster risk reduction would further be stressed because of future climate change.

This Survey conducted field works from November 2007 to March 2008 and then the assistance program (Draft) was formulated. The assistance programs were prepared in accordance with the Task-oriented approach as envisaged in the "Country Assistance Program for the Philippines (June 2008)" based on the "Selection and Centralization" concept of ODA. The survey formulated and compiled a total of eight programs/projects in various schemes in the disaster management sectors through substantial review on the characteristics of recent natural disasters in the Country.

The outline of the cooperation program was drafted as follows:

(1) Objective
- To target 50 % reduction of damage due to natural disasters
- To cope with climate change as well

(2) Period: From 2008 to 2017 (10 years)

(3) Composition of the program/project

<Government level and community-based disaster management>

- Project for disaster risk reduction and management capacity enhancement* (Technical Cooperation)

<Flood and debris flow prevention>

- Project for strengthening of operation and maintenance of river structures (Technical Cooperation)
- Project for strengthening of information dissemination to the communities (Technical Cooperation)
- Project for environmental improvement of waterfront in Iloilo City (JOCV)*
- Nationwide flood risk assessment project and the flood mitigation plan (Development Study)*
- Disaster management sector loan (Yen Loan)
- Flood management project in urban areas (Yen Loan)*

<Volcanic eruption and earthquake disaster prevention>

- Mayon Volcano Disaster Prevention Project

Note: *, Under implementation as of April 2013

Regarding the strengthening flood monitoring and forecasting capability, the Program Formulation Survey recommended as an integrated river information sub-program focusing flood forecasting and warning system, rainfall radar system and dam discharge. In fact, the "Project for Strengthening of Flood Forecasting and Warning System for Dam Operation" has been conducted and completed in 2012. However, the Program did not mention about the needs on expansion of the existing FFWS to other major river basins. Further, it could not foresee the Project NOAH.

5.4 The Study on the Nationwide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas (March 2008)

This Study was conducted by JICA to formulate flood management plans in the selected river basins through 1st and 2nd screening of a total 1,164 river basins. Through the 1st screening, 120 river basins were selected for subsequent secondary examination. Then, 56 river basins were selected and divided into two groups, namely the group to target foreign assistance projects (26 river basins) and the other group to target domestic budget (30 river basins). In accordance with the Final Report in March 2008, after the 2nd screening, six model river basins were selected and further studies were conducted at preliminary master plan level in terms of accuracy of the overall Study.

In this Study, in order to assess the flood potential areas in the respective river basins, preliminary flood inundation analysis based on the topographic maps (national base maps of NAMRIA) of 1:50,000 was conducted. The flood potential area maps are available in the Final Report as well.

CHAPTER 6 CURRENT STATUS ON OPERATION OF EXISTING FFWS/FFWSDO

6.1 Outline of Existing FFWS/FFWSDO in the Philippines

The first flood forecasting and warning system in the Philippines was introduced in the Pampanga River basin as the Pilot Project by Typhoon Committee, UN, in 1973. Since then, FFWS has been continuously developed with the assistance of mainly JICA and other Japan related fund sources; now, it has been expanded to five river basins namely the Cagayan, Agno, Pampanga, Pasig-Laguna de Bay (Marikina) and Bicol River basins. The river basins, experienced heavy damage due to significant typhoons, were prioritized for installation of telemetered monitoring systems. Each system is composed of sub-systems for monitoring of rainfall and water levels, issuance of warnings, data transferring and communication with other agencies concerned. Figure 6.1.1 illustrates the latest configuration of FFWS/FFWDO in the aforesaid five river basins. Detailed configurations of the monitoring equipment and latest conditions are described in Chapter 9.

In the Philippines, the flood forecasting and warning system (FFWS) is generally divided into two, i.e. FFWS for river basins and FFWS for dam operation (called as “FFWSDO”). FFWS is operational in the five river basins although there are stretches partially not operational at present. The Effective Flood Control and Operation System (EFCOS), which was initially installed in 1988 and rehabilitated in 1995 by the assistance of the Government of Japan, has been consistently managed by the Metropolitan Manila Development Authority (MMDA). On the other hand, the data of EFCOS are transmitted to PAGASA WFFC as well to enable PAGASA for assisting flood operation of MMDA from rainy season in 2013. The present situation of EFCOS was confirmed through the interviews to the MMDA staff in the current Survey as presented in Appendix D.

On the other hand, total five FFWSDO such as the Cagayan/Magat, Agno, Upper Pampanga, Angat and Caliraya FFWSDO) are operational. In principal, PAGASA and dam operators (NIA/NPC) is responsible to manage FFWS and FFWSDO respectively. However, in actuality, PAGASA closely coordinate with dam operators to appropriately operate the FFWSDO.

In the remaining 13 major river basins, current situation of flood monitoring is rather different from other five telemetered river basins because of limited number and type of gauging stations for rainfall and water level. Therefore, timely issuance of flood warning and information with required accuracy is currently difficult in the regions.

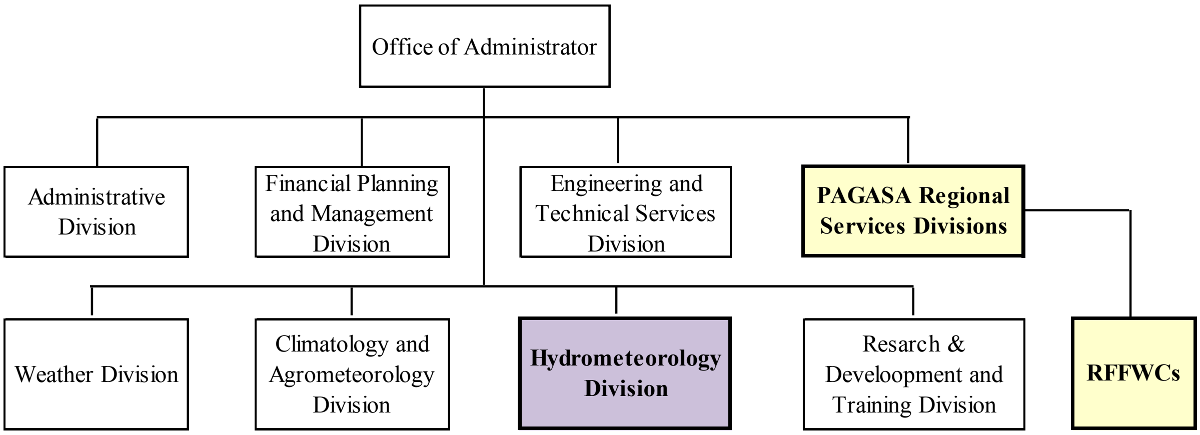
Tables 6.1.1 and 6.1.2 show the target areas of FFWS and FFWSDO respectively. Figure 6.1.2 illustrates the target areas of existing FFWS/FFWSDO in the Cagayan, Agno and Pampanga River Basins.

6.2 Organizational Situation of PAGASA and Job Categories of HMD

6.2.1 Organizational Structure of PAGASA and Hydrometeorology Division

The latest overall organizational structure of PAGASA and HMD were confirmed with the management staff concerned to identify the crucial issues for future development of FFWS/ FFWSDO in the light of capacity development,

The current organizational structure of PAGASA consists of eight divisions as shown below:



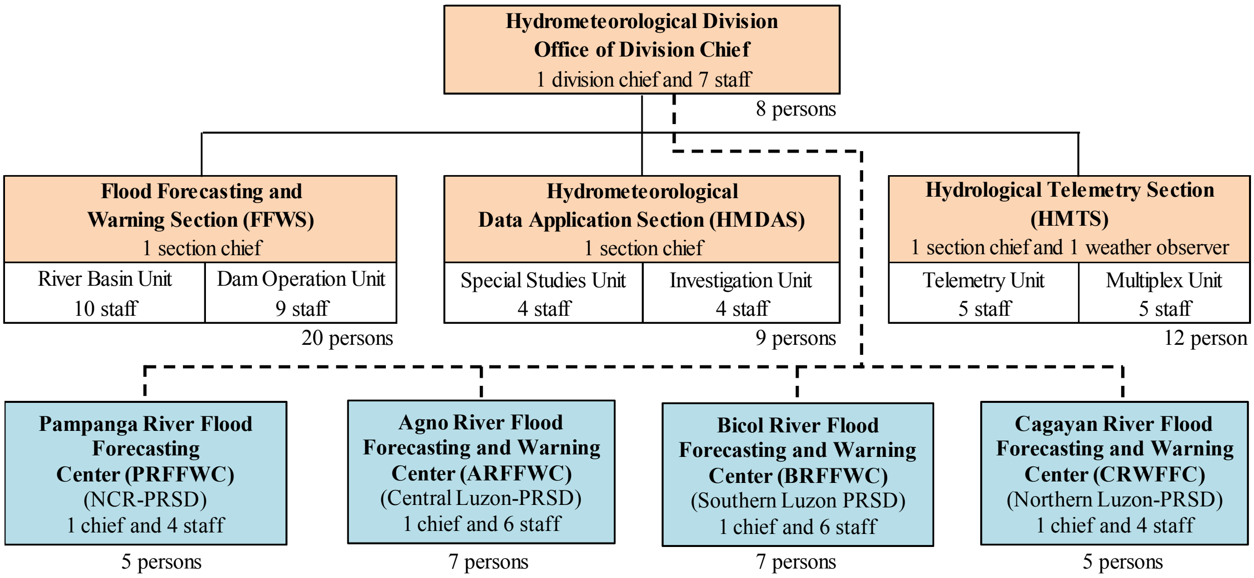
Source: PAGASA

Organizational Structure of PAGASA

The Hydrometeorology Division (HMD) is responsible for the operation of all FFWS in the five river basins namely: Cagayan, Agno, Pampanga, Bicol, and Pasig-Marikina. Further, in these telemetered river basins, the River Flood Forecasting and Warning Centers (RFFWCs) are operated under PAGASA Regional Services Divisions (PRSD) as shown above. In case of the Pasig-Marikina River basin,

Close coordination between HMD and PAGASA Regional Services Division (PRSD) is indispensable particularly in flood operations such as the issuance of flood bulletins and other flood information regarding the concerned river basins. For the maintenance of the equipment and other appurtenant structures at gauging stations, the Hydrometeorological Telemetry Section (HMTS) assists the PRSD staff in their routine work of keeping them in order.

Therefore, the Division Chief of HMD usually closely coordinates and works with the representatives of PRSD to watch and monitor the overall system. During flood operation, he or she keeps communication through a dedicated line with RFFWCs to assist in the timely issuance of flood bulletin/information. The organization of HMD can be further broken down into three sections under the Office of Division Chief as follows:



Source: PAGASA HMD

- HMD : 49 persons
- RFFWCs (under PRSD) : 24 persons

Total : 73 persons

Organizational Structure of HMD

The number of staff is 49 persons in HMD and 24 persons in PRSD as of September 2013 as seen in the structure.

6.2.2 Job Categories

The routine jobs related to FFWS activities of HMD can be divided into 11 categories based on the "Operation Manual of Flood Forecasting and Warning System for River Basin (Updated Edition, October 2012)" [1]as follows:

(1) Basin/river system monitoring
(2) Data collection for flood forecasting
(3) Database management
(4) Discharge measurement
(5) Assessment and update of Flood Warning Water Levels
(6) Flood forecasting
(7) Issuance of flood information
(8) Post-flood investigation
(9) Public information and education drive
(10) Telemetry and telecommunication
(11) Flood drills

It should be noted that the above job categories are contemplated for the flood operation of

[1] This Manual was originally prepared by "The Project for Strengthening of Flood Forecasting and Warning Administration" (November 2005, JICA). Then, in the course of "The Project for Strengthening of Flood Forecasting and Warning Operation" (November 2012, JICA), it was updated and compiled to form part of the "Updated Flood Warning Manual for Dam Target Areas".

telemetry system in the Cagayan, Pampanga, Agno, and Bicol River basins. The manual aforementioned is effectively utilized for routine flood operation in HMD. Therefore, upon establishment of new FFWS in other 13 major river basins, new manuals also should be prepared based on the existing one.

6.3 Flood Forecasting and Warning Operation by PAGASA HMD

The HMD's FFW operation is conducted at the PAGASA WFFC Building, PAGASA Central Office and at each River Center. Administrated by the Main Operation Center (MOC), it is managed by both FFWS and Hydrometeorological Telemetry Section (HMTS) personnel.

Functions of each section in PAGASA are enumerated as follows:

(1) HMD (Division Chief)

- To formulate, administer, and review the implementation of the FFW operation by hydrology plan, programs, and policies;
- To coordinate the general FFW operation with the river centers, as well as the relevant agencies involved in flood disaster risk management;
- To coordinate with NIA, NPC, DPWH, OCD and others regarding the FFWSDO and EFCOS; and
- To maintain local/international hydro-related linkages/cooperation.

(2) Flood Forecasting and Warning (FFW) Section

- To monitor the meteorological and hydrological conditions of the country's river basins/systems for the provision of hydrological/flood information packages which are described in the sub-sections hereinafter;
- To collaborate with NIA and NPC in the implementation of the hydrological aspect of FFWSDO, MMDA of EFCOS, and other agencies involved in flood disaster risk management;
- To improve the methods, procedure and techniques in hydrological (flood) forecasting and warning; and
- To conduct public information /education on the floods and other related topics in the national level.

(3) Hydrometeorological Data Application Section (HMDAS)

- To undertaken basic hydromet/hydrologic data acquisition and processing for the provision of hydromet/hydrologic predictions or design storms, hydro forecasting models, flood hazard maps, and other applications;
- To improve the methods, procedures, and techniques in the hydromet/ hydrologic applications and in the maintenance of the Division's database management system;
- To monitor non-real-time data acquisition and primary processing; and
- To coordination with PRSD regarding the outputs of the hydro-metrological station network.

(4) Hydrometeorological Telemetry Section (HMTS)

- To monitor the overall operation and maintenance of the telemetry/ telecommunication system networks, telemetry gauging instruments/ equipment for real time hydrologic data acquisition;
- To improve the methods and procedure in the operation and maintenance of the telemetry, microwave radio, and network telecommunication system;
- To collaborate with NIA and NPC in the implementation of telecommunication aspect of FFWSDO.

(5) River Centers (Pampanga, Agno, Bicol, and Cagayan)

- To monitor the meteorological and hydrological conditions of the concerned river basin, and dam operation in coordination with the FFW Section excluding Bicol, for the issuance of various hydrological information packages;
- To conduct river hydrographic survey and primary data processing, and basin post-flood investigation in coordination when HMDAS and FFWS;
- To maintain the hydrological observation facilities and telemetry system of the basin, including the electro-mechanical and gauging equipment/instruments, in coordination with HMTS;
- To conduct public information drives on floods and other related topics in the local level; and
- To collaborate/cooperate with local institutions involved in flood disaster mitigation, and other related activities.

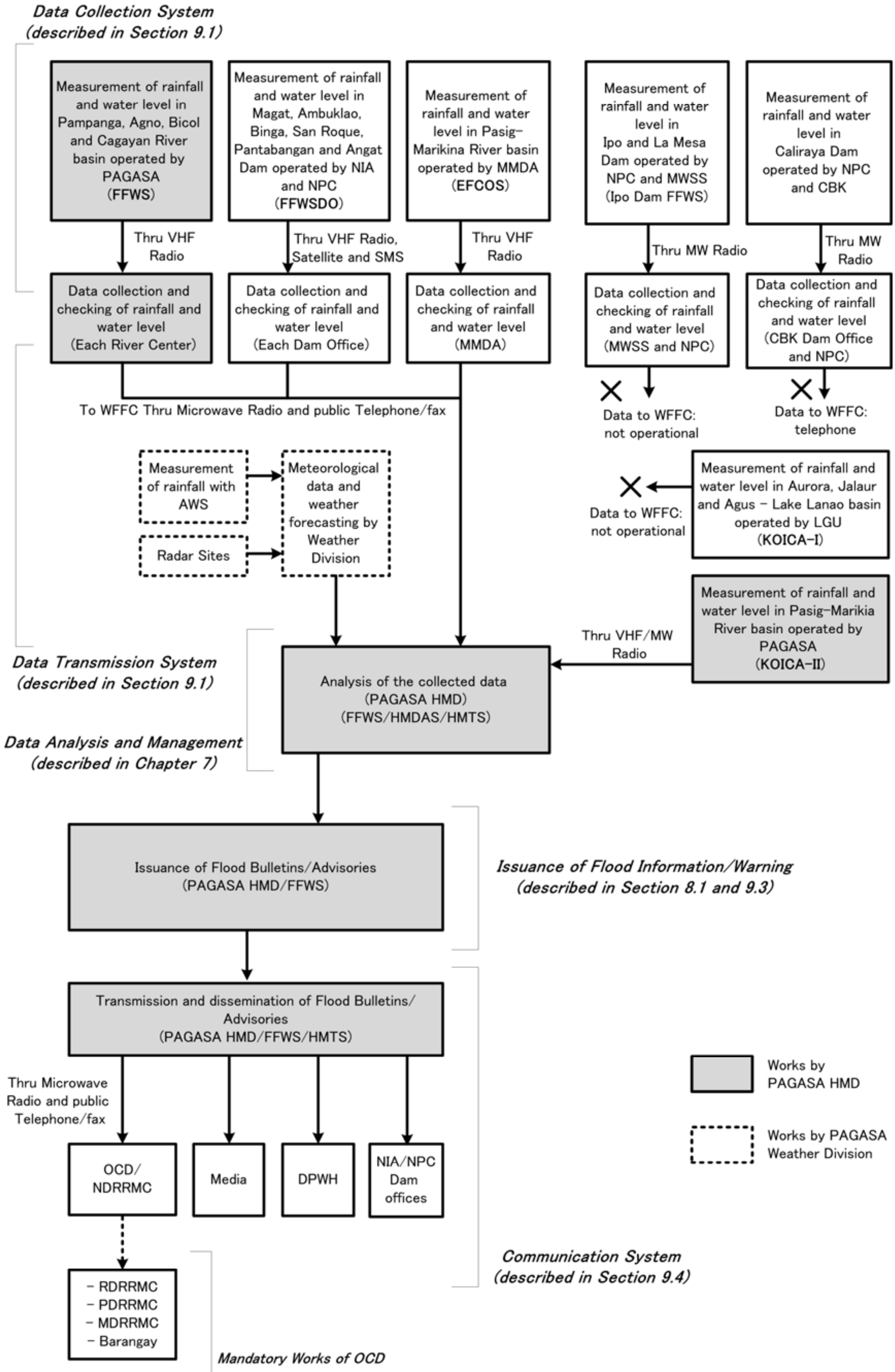
(6) Main Operation Center (MOC)

- To oversee/advice/coordinate the meteorological and hydrological conditions of the river centers;
- To provide support/technical assistance, etc. to the various Local or Community-Based Flood Early Warning Systems (CBFEWS);
- To prepare/issue/ upload a region general flood advisory for some river systems with or without a river center;
- To transmit PAGASA data and information (severe weather bulletin, public weather forecast etc) to the river centers, NIA, NPC, DPWH, NWRB, MMDA, OCD and other collaborating agencies;
- To acquire copies of all flood-related information prepared by the river centers, DPWH and other sources for reference and/or issuance to interested users, agencies and the media; and
- To conduct briefings for the media and other interested parties on floods and other hydrological hazards.

The MOC shall be operated by duty personnel of FFW section and HMTS. Its overall duties and responsibilities shall be implemented under the direction/supervision of the Chief, FFWS or Duty Sr. Flood Forecaster.

The MOC is also the lead center for inter-agency “FFWSDO” and monitoring of EFCOS.

An overall flow of the flood forecasting and warning operation by HMD is illustrated as shown below:



Overall Flow of Flood Forecasting and Warning Operation of PAGASA HMD

6.4 On-going Foreign-Assisted Projects

Various projects/programs related to FFWS/FFWSDO, which are supported by national finance and donor's resources, are in progress under PAGASA HMD. A total of 17 project/programs are on-going in parallel. The project title, study/area, name of donor, project period and focal points in PAGASA are summarized in Table 6.4.1. Further, the relationship among the 19 target river basins and components covered by each project (on-going foreign-assisted projects) are tabulated in Table 6.4.2. Further detailed information of the projects are presented with ten issues (title, donor agency, target area, project period, budget, contact person of PAGASA, objective/salient feature, current status, notable issues and data source) as compiled in Appendix E.

As seen in the list, it is inevitable that PAGASA HMD will need to manage activities associated with each project. However, there is a limited staff – approximately 50 persons from year 2010. Although HMD is recruiting new staff and conducting a series of trainings to cope with lack of staff, it is still maintained at inadequate level.

6.5 On-going National Funded Projects

The Nationwide Operational Assessment of Hazard Project (Project NOAH) consisting of eight components is currently implemented by DOST with the budget of the Government of Philippines. The current status of the Project NOAH is described in Appendix F.

CHAPTER 7 CURRENT STATUS AND ISSUES TO BE SOLVED ON MONITORING, DATA MANAGEMENT AND ANALYSIS

7.1 Meteorological and Hydrological Monitoring

7.1.1 General Features

FFWS contributes to evacuations from floods. Meteorological and hydrological monitoring systems are fundamental features of FFWS. Currently the main target weather disturbance of PAGASA FFWS is the large scale disturbances such as tropical cyclones and monsoon rains. The water level gauges monitor water levels at target river channels, and used as references for flood warning dissemination to surrounding areas of target river channels. The rainfall gauges serve to monitor rainfall depth at target areas, and the observed rainfall intensities are used as references for flood warning dissemination to wide expanse of target regions.

7.1.2 Current Status

(1) Existing Rainfall and Water Level Gauging Stations

The rainfall and water level monitoring in the Philippines is observed by various agencies as shown in the following table:

Rainfall and Water Level Observation in the Philippines

No.	Agency	Rainfall		Water Level	
		Type	Data Transmission	Type	Data Transmission
1	PAGASA HMD	1) FFWS station (PABC, KOICA II)	1) Telemeter	1) FFWS station (PABC, KOICA II)	1) Telemeter
2	PAGASA RSD	1) AWS station 2) ARG station 3) Synoptic station	1) SMS 2) SMS 3) Manual Operation	N/A	N/A
3	NIA	1) FFWS station (PABC) 2) Rainfall station for irrigation (Daily)	1) Telemeter 2) Manual Operation	1) FFWS station (PABC)	1) Telemeter
4	NPC	1) FFWS station (PABC)	1) Telemeter	N/A	N/A
5	MMDA	1) FFWS station (EFCOS)	1) Telemeter	1) FFWS station (EFCOS)	1) Telemeter
6	ASTI (NOAH project)	1) AWS station 2) ARG station	1) SMS or satellite 2) SMS or satellite	1) WLMS	1) SMS or satellite

Source: Study Team

The lists of existing rainfall and water level gauging stations for each target river basin are compiled in Appendix G. The locations of rainfall and water level gauging stations are shown in Appendix H. The numbers of stations are summarized below:

Number of Existing Stations

		Luzon	Mindanao	Visayas	Total
ARG	ASTI	50	34	17	101
	MMDA EFCOS	7	0	0	7
	PAGASA HMD	74	0	0	74
	PAGASA RSD	54	12	11	77
	Sub-Total	185	46	28	259
AWLG	ASTI	52	8	6	66
	MMDA EFCOS	10	0	0	10
	PAGASA HMD	45	0	0	45
	Sub-Total	107	8	6	121
AWS	ASTI	39	23	20	82
	PAGASA RSD	41	19	15	75
	Sub-Total	80	42	35	157
Total		372	96	69	537

Note: Number of ASTI stations is as of 17 January 2013
KOICA stations in the Pasig-Marikina River basin were transferred from PAGASA RSD to HMD.
Source: Study Team

The density of existing stations in each region is shown below:

Density of Existing Stations

	Luzon	Mindanao	Visayas
ARG	13.21	4.57	5.07
AWLG	7.64	0.79	1.09
AWS	5.71	4.17	6.34

Unit: Number of stations / 10,000 km^2

Area of Islands

	Luzon	Mindanao	Visayas
Area	140,003	100,737	55,240

Unit: km^2
Source: Study Team

The densities of ARGs in the Visayas and Mindanao areas are approximately 40% and 35% respectively, of the stations in Luzon. The densities of AWLG in the Visayas and Mindanao are approximately 15% and 10% respectively, of the stations in Luzon.

(2) Additional Gauges Installed by Ongoing Projects under PAGASA-HMD

There are several ongoing projects under PAGASA-HMD which intend to install additional rainfall or water level gauging stations in several target river basins.

Installation Plan of Rainfall and Water Level Gauging Stations (1/2)

No.	Project Name	Target Area	Number of Rainfall Stations	Number of Water Level Stations
1	Strengthening of Flood Forecasting and Warning System in the Bicol River Basin ("Bicol Project")	Bicol River basin	11 stations	7 stations
2	Strengthening of Flood Forecasting and Warning System on Magat Dam and Downstream Communities ("Norad Project")	Cagayan River basin (Magat watershed)	21 stations	10 stations

Source: PAGASA HMD as of May 2013

Installation Plan of Rainfall and Water Level Gauging Stations (2/2)

No.	Project Name	Target Area	Number of Rainfall Stations	Number of Water Level Stations
3	Building Community Resilience and Strengthening Local Government Capacities for Recovery and Disaster Risk Management ("Resilience Project")	GMMA	22 stations	1 station
4	Applying Remote Sensing Technology in River Basin Management in the Philippines	Cagayan River basin	Not decided yet	-
5	Enabling the Cities of Cagayan de Oro and Iligan to Cope with Climate Change ("Project Climate Twin Phoenix")	Cagayan de Oro River basin and Mandulog River basin	Not decided yet	Not decided yet
6	Disaster Preparedness and Response Project	Pasig-Laguna de Bay	Not decided yet (AWS)	-

Source: PAGASA HMD as of May 2013

(3) Additional Gauges Installed by NOAH Hydromet Project

ASTI has installed approximately 250 rainfall and water level stations throughout the Philippines as of January 2013. The Project was carried out in the “Distribution of Hydrometeorological Devices in Hard-hit Areas in the Philippines” (Hydromet) under NOAH Project. A total of 1,000 of rainfall and water level stations are scheduled to be installed by the end of 2013.

(4) Observation of Tide Level

In the Philippines, tide levels are observed by NAMRIA. The location map of tide stations are shown in Figure 7.1.1. There are water level gauges in the river mouth of basins where there is no NAMRIA tide station at present.

7.1.3 Crucial Issues for Future Development

(1) Setting Target for Installation of Rainfall and Water Level Stations

There are several methods for observation of rainfall, such as in-situ rainfall gauges, rainfall radars and satellite observations. The target density of in-situ rainfall gauges should be set for development of sustainable system, considering target types of weather disturbances and hydrological characteristics of target basins. If the current density of stations is not enough, the additional stations should be installed.

In case of water level monitoring, target area of flood warning dissemination should be set in the initial stage. The water level monitoring stations should be appropriately located to monitor water levels of the target river channels, considering hydrological characteristics.

(2) Additional Rainfall and Water Level Gauging Station by Project NOAH

Various rainfall and water level gauging stations were installed by the NOAH Project throughout the Philippines. The number of rainfall and water level gauging stations vary in each river basin, with some basins having fewer stations. Future plans for installing additional rainfall and water level gauging stations by the NOAH project will be proposed in river basins with fewer numbers of stations.

However, the target density of rain gauges and target river channels for water level monitoring should be set for development of sustainable system. If the current density of stations is not enough, the additional stations should be installed.

(3) Duplication of Rainfall and Water Level Stations

The some rainfall and water level stations were installed in the same location by several agencies. The following two locations are mentioned as examples:

1) Rainfall Stations in PAGASA Science Garden (Pasig-Marikina River basin)

   (a) PAGASA synoptic station

   (b) PAGASA AWS station (KOICA I)

   (c) MMDA ARG station (EFCOS)

   (d) NOAH AWS station (ASTI)

   (e) ASTI ARG station

2) Water Level Gauging Stations in Napindan (Pasig-Marikina River basin)

   (a) PAGASA station (KOICA II)

   (b) MMDA station (EFCOS)

   (c) NOAH station (ASTI)

The pictures of rainfall gauges at PAGASA Science Garden are shown in Figure 7.1.2.

The observed values of several stations above have discrepancies according to PAGASA staff. The observed rainfall depth and water level during a flood event on 2013 August were examined in Appendix I.

Duplications in installing stations would mean loss of available resources such as budget and/or staff. Plans for the installation of rainfall and water level gauges should be improved.

(4) Reliability of Monitoring Data

The ARG and AWS stations under PRSD, except for FFWS stations, have been in operations since 2008. The accuracy of these monitoring stations is presently being tested by PAGASA; this should be clarified due to the influence it will have on the operation of FFWS.

(5) Classification of Stations

According to PAGASA, some ARG, AWS and AWLG equipment have low accuracy. For example, PAGASA mistrust the accuracy of noncontact type water level sensor, such as ultrasonic type. However, it is not appropriate to recognize that the accuracy of ultrasonic type sensors is low and pressure type sensors with relatively high accuracy should be installed. Installation of ultrasonic type sensors is easier than the setting up of pressure type sensors. The installation of ultrasonic type sensors in the area with few stations will improve the situation of monitoring basins, which is better than nothing.

Rainfall and water level stations should therefore be classified considering the accuracy and characteristics of sensors. If these characteristics will not be carefully considered in the operation of FFWS, confusion will occur.

(6) Sharing of Tide Level

Observed tide levels should be shared between PAGASA and NAMRIA during flood events.

7.2 Data Management

7.2.1 General Features

The meteorological elements are manually observed and recorded in primitive stage of monitoring. Those records are manually sent from monitoring stations to headquarters of the meteorological agency. The headquarters archive data, and conduct quality control activities. After installation of FFWS, frequency of monitoring and number of stations are drastically increased. For example, frequency of manual rainfall monitoring is mostly daily, and its automated monitoring is hourly or even every 10 minutes. The main changes in data management works corresponding to installation of FFWS are listed below:

- Rainfall depths and water levels are observed automatically. However, periodical or occasional inspections should be conducted to check whether equipments work properly.
- Observed data should be transferred from gauges to river centers and headquarters.
- Data should be stored in database automatically.
- Stored data should be checked in data quality control activities. The methods of quality check should be established considering limited number of staffs.

7.2.2 Current Status

(1) Data Management System

Established FFWS in five river basins centralize obtained data by gauges to river centers. Data are automatically sent from river centers to PAGASA HMD in real time, in cases of the Pampanga, Agno, and Pasig-Marikina river basins. The observed data can be monitored in both of river centers and HMD. However, the system interfaces are not designed considering secondary use of data. Due to insufficient data exporting interface or connection of the systems, the monitoring data through water level and rain gauges of FFWS is manually entered into Microsoft Excel spreadsheets.

(2) Quality Control of Archived Data

Collected data by synoptic and agromet stations are archived and quality-controlled by the Climatological and Agrometeorological Division of PAGASA. The quality of data in a couple of FFWS basins are controlled by the river centers.

7.2.3 Crucial Issues for Future Development

(1) Automation of Data Management

PAGASA will expand its FFWS target river basins. It means that the amount of data will increase rapidly. Automation of data management will be necessary.

(2) Integration of Observed Data

Monitoring systems for FFWS are currently installed as stand-alone systems. Observed data should be stored in one place and integrated for effective use.

(3) Strategy of Quality Control of Archived Data

It is probable that conducting quality control on all ARG, AWS and AWLG will be difficult considering the present capacity of PAGASA. The strategy of quality control on ARG, AWS and AWLG data should be established.

7.3 Survey Works

7.3.1 General Features

There are three kinds of periodical survey works required for operation of FFWS, namely; zero gauge elevations, river cross sections and discharge measurements. Zero gauge elevations are used to connect monitored water levels to river cross sections and ground levels of flood potential areas. River cross sections are used for estimating river channel flow capacities. Discharge measurements are conducted to establish rating curves (H-Q curves) which are used to estimate discharges using monitored water levels. All of three survey works should be conducted periodically, because the state of rivers changes.

River survey works are frequently conducted for other purposes such as planning for structural measures.

7.3.2 Current Status

(1) Zero Gauge Elevations

Zero gauge elevation of all water level gauges for FFWS was surveyed and shown in the Operation Manual of FFWS of PAGASA. However, zero gauge elevations are not surveyed for water level monitoring stations established by Project NOAH.

(2) River Cross Sections

River cross section surveys are conducted for the establishment of flood forecasting models, planning and design of river channel improvement, construction of dams, etc. The inventory information of currently available river cross section data is shown in the following table:

Inventory Information of River Cross Section Data (1/2)

No.	River Basin	River Name	No. of Cross Section	Distance (km)	Survey Year	Agency
1	Cagayan	Magat	47	47.5	2010	NIA
2	Agno	Agno	311	60.7	1993	DPWH
3	Agno	Poponto Floodway	41	10.8	1993	DPWH

Source: Study Team

Inventory Information of River Cross Section Data (2/2)

No.	River Basin	River Name	No. of Cross Section	Distance (km)	Survey Year	Agency
4	Agno	Tolongan	4	1.0	1993	DPWH
5	Agno	Bakit Bakit	7	1.7	1993	DPWH
6	Agno	Chico	6	1.6	1993	DPWH
7	Agno	Lagasit	5	2.4	1993	DPWH
8	Agno	Tarlac	37	41.6	2002	DPWH
9	Agno	Agno	48	67.6	2010	PAGASA
10	Pampanga	Pampanga	29	44.2	1982	DPWH
11	Pampanga	Pampanga	99	22.7	1989	DPWH
12	Pampanga	Labangan Floodway	77	17.0	1989	DPWH
13	Pampanga	New Bagbag Channel	24	4.6	1989	DPWH
14	Pampanga	Pampanga	56	49.5	2010	PAGASA
15	Pampanga	Angat	78	67.2	2010	PAGASA
16	Pasig-Laguna	Meycauayan	6	13.3	2008	DPWH
17	Ilog-Hilabangan	Ilog	6	26.3	2008	DPWH
18	Cagayan de Oro	Cagayan de Oro	38	17.6	2013	DPWH

Source: Study Team

(3) Discharge Measurements

Discharge measurements are described as tasks of river centers in the Operation Manual of FFWS, and they are required to conduct frequent measurements to obtain data homogeneously from low to high water levels. However, measurements are infrequently conducted due to limitation of staffs and budgets.

7.3.3 Crucial Issues for Future Development

(1) Connection of Water Level Monitoring and River Cross Sections

Observed water level data is shown as numbers on FFWS monitoring system. Observed water levels and river cross sections are shown together only in the Pasig-Marikina FFWS (EFCOS and KOICA). The observed water level data and river cross sections should be shown together in the monitoring system to make viewers understand the degree of seriousness of flood.

(2) Quality of Survey Works

In the JICA TCP (2012), it was pointed out that accuracy of river cross sections were low due to unreliable benchmarks. The system to check the ability of survey contractors should be established. Frequent communication with NAMRIA should be required.

(3) Sharing of River Cross Section Data

There is no river management agency, and the river cross section surveys are conducted by several agencies for their own purpose. The proper coordination among related agencies is good for effective use of outputs. In case of the Pasig-Marikina River, the river cross section surveys were conducted by JICA and DPWH for the Pasig-Marikina River Channel Improvement Project, and the survey data was provided to PAGASA for flood model establishment. Consequently, PAGASA could save the budget and time.

In addition, most of these data are still archived in paper and have not been converted in digital format. The river cross section data should be archived in digital format and the inventory information should be shared among related agencies.

(4) Update of River Cross Section Data

River cross section data is used to establish flood runoff models and to estimate flood discharges by using H-Q curves. The shapes of cross sections vary due to sedimentation or scouring. Observed water level or discharge data can be affected by the shapes of cross sections, and those observed data should be associated with contemporary river cross sections. The relationship will be helpful in improving the accuracy of flood runoff models, establishment of models or operation of FFWS. Besides, river cross section data should be updated occasionally.

(5) Target Stations for Discharge Measurements and Work Demarcations

H-Q curves are used to estimate discharges using observed water levels. Those estimated discharges are useful especially in basins with existing or planned structures for regulating water, such as dams, floodways, and retarding reservoirs, because the capacity of those structures are expressed in volume of water. Discharge measurements related to said existing or planned structures should be conducted by the agencies responsible for operation or construction. Furthermore, budget and staffs for discharge measurements should be prepared. Considering limitation of budget and staffs, target stations for discharge measurement should be carefully selected. For instance, it is recommended that discharge measurements in the Pasig-Marikina River should be conducted by DPWH at Sto. Nino WL gauging station for the Pasig-Marikina River Improvement Project.

7.4 Flood Forecasting Models

7.4.1 General Features

Flood warnings can be disseminated using monitored water levels in primitive stage of FFWS, and trends of water levels can be estimated manually with rainfall in the upstream areas. However, if flood forecasting models are introduced, the accuracy of forecasting will be improved. And, lead time for evacuation will become longer.

The easiest forecasting model is stage correlation method. The second choice is flood runoff models. There are several kinds of flood runoff models. Detailed flood runoff models require a lot of data and effort for establishment and calibration of models, however those provide accurate forecasting. On the other hand, simple models require a few data and effort, and provide lower accuracy. As a procedure of model development, simple models should be adopted at first. If the accuracy of simple models is not enough for operation of FFWS, then detailed models should be employed.

For establishment of accurate flood runoff models, appropriate numbers of rainfall gauges should be installed in the upstream area to estimate basin mean rainfalls. Historical records of rainfall and water levels or discharges should be archived for calibration of models. River cross section surveys and discharge measurements should be conducted.

7.4.2 Current Status

Several flood runoff models have been recently established in the Philippines for flood forecasting and warnings. The list of flood runoff models and calibration statuses is shown in Table 7.4.1.

(1) JICA TCP

Flood runoff models using storage function method were developed in the Cagayan, Agno, and Pampanga River basins by “The Project for Strengthening of Flood Forecasting and Warning System for Dam Operation, JICA” (JICA TCP). Storage function method is simple conventional method, and it was employed in Japan for several decades for the purpose of water resources plans and flood control plans. Flood runoff models developed by JICA TCP covered only areas influenced by dam outflow. These models did not cover the whole river basin.

(2) ICHARM

Integrated Flood Analysis System (IFAS) was experimentally applied in the Cagayan and Pampanga river basins by ICHARM. One of advanced functions of IFAS is the interface which allows users to employ estimated rainfalls by satellite technologies. The detailed information of IFAS model is described in the Chapter 10.

(3) RAP

The GMMA Risk Assessment Project (RAP) by AusAID and the Government of Australia established the flood runoff model for the Pasig-Marikina River basin. The Project used Hydrologic Engineering Centers Hydrologic Modeling System (HEC-HMS) and Hydrologic Engineering Centers River Analysis System (HEC-RAS) software with LIDAR elevation data. HEC-HMS and RAS are developed in US, and can be downloaded from the web site for free. HEC-RAS employs one dimensional hydrodynamic equation which is used to analyze water levels considering tidal levels.

(4) NOAH FloodNET

The flood runoff model for the Pasig-Marikina River basin was established by the University of the Philippines (UP) for the Flood Information Network (Flood NET) Project. FloodNET is one of the projects under the Nationwide Operational Assessment of Hazards (NOAH). The Project also employed HEC-HMS and HEC-RAS.

(5) NOAH DREAM

The Disaster Risk Exposure Assessment for Mitigation Project (DREAM) under the NOAH Project is currently conducting hazard map analysis by using HEC-HMS and HEC-RAS with LIDAR elevation data. These hazard map models may also be used in the Flood NET Project as flood forecasting models. The hazard maps at the Pasig-Marikina, Cagayan de Oro and Mandulog River basins are disclosed on their website. Further development of hazard maps in the Agno, Bicol, and Davao River basins are being planned.

7.4.3 Crucial Issues for Future Development

(1) Expansion of FFWS Target Basins and Stepwise Approach of Model Development

Currently, the flood runoff models for flood forecasting and warning are only available in the Agno, Cagayan and Pampanga river basins for FFWSDO. The models in other basins among the 18 major ones should be established.

However, it is not realistic to apply flood runoff models in all of the 18 major river basins very soon. Stepwise approach should be applied. The stepwise approach is discussed in Chapter 11.

In addition, a standardized flood runoff model is not available. Therefore, several types of models were employed. A strategy for model selection, model development, and training for model use will be required for expansion of flood runoff model application (it does not mean that a standardized flood runoff model should be established).

(2) Coverage Area of Existing Flood Runoff Models

The flood runoff models developed by JICA TCP covered only the target areas of FFWSDO, and not the whole river basin. The flood runoff models for the target areas of FFWS should be also established.

(3) Further Calibration of Existing Flood Runoff Models

Flood runoff models that are currently available were established from limited data. Updating of model parameters is further required for accurate flood forecasting and warnings.

7.5 Inundation Analysis

7.5.1 General Features

Inundation analyses are employed to delineate flood potential areas, which are used to set target areas of FFWS and to let people know potential of flood hazards.

Inundation analysis models can be used for inundation forecasting. Residents in flood potential areas are able to easily know seriousness of floods from the forecasting. However, meteorological and hydrological data, river cross sections, detail elevation data should be prepared to establish the models.

7.5.2 Current Status

Available inundation analysis outputs were categorized into five types as shown below. The target basins of the inundation analyses are summarized in Table 7.5.1.

(1) Identification of Flood Potential Areas by Morphological Analysis

There are a couple of flood potential area maps or flood hazard maps by morphological analysis in the 18 major river basins and the Mandulog River basin.

- The READY Project: CSCAND agencies such as PHIVOLCS, PAGASA, MGB, and NAMRIA prepared flood hazard maps by morphological analysis on 1:10,000 scale maps. In the area where 1:10,000 scale maps are not available, they used 1:50,000 scale maps.

- Geohazard Mapping and Assessment Program: This is a Program undertaken by the DENR and being implemented by the MGB. The hazard maps prepared in the program include two major hazards, namely landslides and floods. The maps are shown on the web site of MGB.

(2) Identification of Flood Potential Areas by Hydrological and Hydraulic Analysis

Hydrological and hydraulic analyses to identify flood potential areas are conducted for river improvement projects. Among those projects, FRIMP Project covering the whole Philippines is highlighted below. In addition, some national and foreign funded projects currently focus on this type of analysis in the preparation of accurate hazard maps to help evacuations.

- JICA-FRIMP Project: The flood potential areas of 120 river basins are identified using HEC-RAS and HEC-GeoRAS with DEM and 1:50,000 maps.
- Project NOAH: The flood hazard maps in the Pasig-Marikina, Cagayan de Oro, and Mandulog river basins are prepared using HEC-HMS and HEC-RAS model with LIDAR elevation data. The maps are shown on the web portal site of Project NOAH.

(3) Identification of Flooding Areas by Satellite Remote Sensing Analysis

The flooding areas during flood events and the duration can be monitored by remote sensing technologies.

- DFO: Dartmouth Flood Observatory in the University of Colorado conducts analyses on flooding area by remote sensing technologies, and shows their products on the web. PAGASA currently uses their overlapping products of several flood events for indentifying flood potential areas.
- Sentinel Asia: JAXA conducts trainings on the remote sensing technologies.

(4) Analysis of Flooding Mechanisms by Hydrological and Hydraulic Analysis

The inundation analysis by MIKE FLOOD software for one and two dimensional hydraulic analysis was conducted in JICA TCP for strengthening FFWSDO. The main purpose of the Project was capacity development of PAGASA staffs. In the course of training, inundation analysis was conducted to analyze flooding mechanisms of comprehensive Pampanga River system.

(5) Inundation Forecasting by Hydrological and Hydraulic Models

There are efforts to develop inundation forecasting systems in Project NOAH. The Project Team uses HEC-HMS and HEC-RAS model with LIDAR elevation data.

7.5.3 Crucial Issues for Future Development

(1) Coordination among Related Agencies

The inundation mechanisms are related to meteorology, hydrology, river morphology, river structures, and land use. This indicates that there are several agencies related to flood events not only members of CSCAND, but also DPWH, NIA, NPC and LGUs. The proper coordination among related agencies is essential for efficient implementation of inundation analysis and effective use of outputs.

(2) Stepwise Approaches for Establishment of Inundation Forecasting Model
Inundation forecasting is very useful for evacuation. However, establishment of models require a lot of data and efforts. Stepwise approaches should be applied for development of models, and the approaches are discussed in Chapter 11.

(3) Detail Elevation and River Cross Section Data
The accuracy of elevation and river cross sections affect the accuracy of inundation analysis. Detailed elevation and river cross section data, including LIDAR data, will support the development of more reliable inundation analysis models.

(4) Trainings on Remote Sensing Technologies
Remote sensing technologies are powerful for analyzing the flooding situation especially in un-gauged basins. Trainings on PAGASA and PHIVOLCS will strengthen the monitoring capacities of natural hazards caused by stormy rainfall.

7.6 Post Flood Survey

7.6.1 General Features

Post flood surveys are conducted to know actual situation during floods and damages. In operation of FFWS, flood warnings are disseminated based on the limited information. Surveys after the events can reveal the gaps between estimated flood situation and actual flood situation. Based on the revealed gaps, FFWS operation can be improved.

7.6.2 Current Status

(1) Post Flood Survey in PAGASA
There are descriptions of post flood surveys in the Operation Manual of FFWS of PAGASA. The responsible organizational sections and schedules are shown on the Operation Manual; however, the contents of actions taken are not specified.

After the Typhoons Pedring and Quiel in September 2011, the Pampanga River Flood Forecasting and Warning Center (PRFFWC) of PAGASA prepared post-flood reports compiling the route of typhoon, rainfall and water level fluctuation data, and isohyetal maps, etc. and disseminated them to the concerned agencies.

(2) Post Flood Survey in MMDA
MMDA prepares the flood reports corresponding to the operation of the Rosario Weir beside the Mangahan Floodway. The flood reports include the observed rainfall and water level data, and the records of the operation of the Mangahan Floodway.

(3) Post Flood Survey in other organizations
Flood damage data are available in each province for major flood events. These consist of information sent to OCD-NDRRMC in Camp Aguinaldo, Quezon City.

Nippon Koei Co., Ltd. conducted field inundation surveys in association with the People’s

Disaster Risk Reduction Network, Inc. (one of local NGOs) and collected flood damage data from LGUs affected in Bulacan and Pampanga Provinces. In order to grasp local flood mechanisms and socio-economic conditions in the areas vulnerable to flood, collaboration with LGUs is essential.

7.6.3 Crucial Issues for Future Development

(1) Improvement of Operation Manual of FFWS

The activities for post flood surveys are not described in the Operation Manual. The examples of actions should be described.

(2) Sharing Good Examples

It is noteworthy that activities in PRFFWC shall be encouraged to be continued and be retained in other river basins. It is highly recommended that these good examples should be shared among the staff of HMD and assigned to the other river centers as one of the important activities in the future.

(3) Collaboration with LGUs

The collaboration should be further enhanced between PAGASA and LGUs to indentify the inundation conditions.

(4) Further Implementation of Post Flood Surveys

Post flood surveys should be conducted aiming to improve FFWS operation by revealing the gaps between estimated and actual situations. The present activities in PRFFWC are only preparing summaries of observed data. Further activities to improve FFWS operation should be conducted.

CHAPTER 8 CURRENT STATUS AND ISSUES TO BE SOLVED ON FLOOD INFORMATION AND COORDINATION SYSTEM

8.1 Issuance of Flood Information/Warning

8.1.1 Current Status

(1) Overall regulation for issuance of flood information/ warning

The Operation Manual for FFWS in the Pampanga, Agno, Bicol and Cagayan River basins was prepared in 2005 through “The Project of Flood Forecasting and Warning System for River Basin, 2005” under JICA. Then, this Manual was updated though “The Project for Strengthening of Flood Forecasting and Warning System for Dam Operation, November 2012” (to be referred to as “former JICA TCP”), which mainly incorporated the current revisions conducted by PAGASA in the course of routine operations after 2005.

In accordance with the Operation Manual, the HMD prepares and issues several types of flood information for the river basins. These include basin flood bulletins (regular and intermediate), basin hydrological forecasts, and basin and region[1] general flood advisories. All of these serve a common purpose. These are intended to inform or warn people of the present/expected hydrological conditions and to suggest or recommend, when necessary, flood disaster prevention and damage mitigation measures.

In principle, the issuance of the “Basin” flood information is the responsibility of the RFFWCs and the “Region” flood information is to be issued by the PAGASA HMD.

On the other hand, monitoring records of the Project NOAH is not yet easily accessed and referred to by HMD, since the data server of the NOAH is not yet fully configured with HMD’s data system. The linkage of both systems is underway. In practice, the HMD staff is checking the data of NOAH’s web site (rainfall and water level records) on monitors as required, to utilize as references for preparation of flood advisory and flood bulletin in the river basins subject to flood monitoring.

In order to consolidate the function of NOAH’s system as one of FFWS tools, the Study Team tried several times to access to the NOAH’s web site to observe rainfall amount in Metro Manila (Pasig-Marilina River basin) during rainfall events in August 2013. However, these were not successful because of failure of connection with the web site.

In accordance with the results, especially in flood operation, NOAH is still uncertain if it can provide reliable and accurate records to the interested individuals and agencies within the required time limits. The overall systems and equipments of NOAH need more calibrations and improvement aiming at stable operation under heavy-duty climate conditions.

(2) Responsible agencies for issuance of flood advisory and bulletins

[1] “Basin” refers to the Pampanga, Agno, Bicol and Cagayan River basins; on the other hand, “Region” means other river basins concerned with flood monitoring.

As for the flood forecasting and warning system for dam operation in the three river basins such as the Pampanga (including Angat), Agno and Magat/Cagayan River basins, the responsibility for issuance of flood information is clearly demarcated as follows:

Agencies/Offices Responsible for Issuance of Flood Information

Category	Agno	Magat/Cagayan	Pampanga	Angat
Flood information for river basin	PAGASA, Agno River FFWC (Rosales) & HMD	PAGASA, Cagayan River FFWC (Tuguegarao) & HMD	PAGASA, Pampanga River FFWC (San Fernando) & HMD	PAGASA, Pampanga River FFWC (San Fernando) & HMD
Dam discharge warning at d/s of dams	NPC San Roque Dam Office	NIA Magat Dam Office	NIA Pantabangan Dam Office	NPC Angat Dam Office

Note: d/s: downstream
Source: "Operation Manual of Flood Forecasting and Warning System for River Basin, Third (Updated) Edition October 2012", which has been compiled as "Section B Updated Flood Warning Manual for Dam Target Areas" under the former JICA TCP.

(3) Flood warning operation in dam target areas

Regarding the flood warning operation in dam target areas (downstream areas affected by dam outflow in three (3) river basins, namely the Pampanga, Agno and Magat/Cagayan), the rules were reviewed and revised through the former JIAC TCP. These were simplified and the Flood Warning Manual was updated with the integration of the Operation Manual of Food Forecasting and Warning System for River Basin prepared in November 2005. It was clarified that the flood warning message by cassette tape sometimes caused confusion. This was established by the FFWSDO Project, at dam discharge warning stations controlled by NIA or NPC dam office through the instruction from PAGASA. In fact, the LGUs at downstream expressed the concern to the dam offices and requested that the system be improved. Four (4) kinds of standard forms for Flood Warning Operation by PAGASA were newly developed and compiled in the Flood Operation Manuals in the former JICA TCP completed in November 2012.

The flood operation in accordance with the products prepared by the former JICA TCP was followed-up and examined in August to September 2013. Quick interviews asking current utilization of flood operation manuals for the Magat/Cgayan and Pantabangan (Upper Pampanga) FFWSDOs to NIA and the San Roque/Binga/Ambuklao (Agno) and Angat FFWSDOs to NPC were conducted respectively. As the results, only NPC replied "Yes" against the question. On the other hand, the current status at dam offices of NIA was unclear regarding utilization of the manuals.

(4) Flood warning water levels

One of the crucial contributions of the former JICA TCP was the revision of the definition of flood warning water levels in the target river basins. The previous definition based on the channel geometry (Critical WL: 100%, Alarm WL: 60%, Alert WL: 40% of flow area at concerned section) was substantially reviewed and revised based on the current rules and standards in Japan as follows:

Flood Warning Water Levels Redefined by the Former JICA TCP

Indicative Terms to be Used	Interpretation by the Former TCP (for better understanding)	Literal Translation in Japan
Critical WL	Water level with risk of large-scale inundation	← Inundation Danger Level
Alarm WL	Water level to start evacuation	← Evacuation Judgment level
Alert WL	Water level to start close monitoring	← Inundation Alert Level

Source: "Volume 1 Main Report" by former JICA TCP, November 2012

In accordance with the redefinition presented above, the flood warning water levels at the Base Points within the dam target areas were duly revised and presented in the updated manuals prepared by the former JICA TCP.

8.1.2 Crucial Issues for Future Improvement

(1) River basins with existing FFWS (Cagayan, Agno, Bicol and Pampanga)

The latest documents of the Operation Manual (Updated Edition, October 2012) shall be fully utilized including technical information for the four river basins equipped with existing FFWS. The contents are still valid. On the other hand, the flood warning water levels at downstream part, which do not fall in the dam discharge affected areas, need to be reviewed in the same manner applied in the former JICA TCP. In this connection, the PC monitors of the current system in PAGASA, OCD and dam offices still show old figures of the flood warning water levels at concerned gauging stations. These shall be duly updated/revised at the earliest possible time to avoid confusion in actual flood operations during the coming rainy season.

(2) Pasig-Marikina River Basin

Through KOICA-II Project, the flood warning water levels were set at major water level gauging stations as far as confirmed on the PC monitors in PAGASA FFWC in Quezon City. However, it is required to further confirm the methodology and background information of such indicative water levels, because consistent definition of flood warning water levels, which was introduced in the target river basins by the former JICA TCP, would become important to avoid future confusion in PAGASA. The application of the same methodology is rather difficult at present due to limited data availability of actuarial flood events, etc. However, it is highly recommended that the procedure of determination of the flood warning water levels should be recorded and kept for elaboration in the future.

On the other hand, the Resilience Project will install one water level gauge along the Pasig-Marikina River. However, the location has not been decided yet as of May 10, 2013. The status will be confirmed in the next field works.

(3) New river basins

The concerned issues in the Operation Manual (Updated Edition, October 2012) shall be referred to in the new river basins; in particular, the manner for issuance of Regional Flood Information concerned. On the other hand, it is recommended that even a simple guideline exclusively for specific river basins be made before preparation/compilation of a comprehensive manual for the river basin(s).

Since the Project NOAH has no plan and/or component to prepare any manual for future operation and maintenance, PAGASA might be responsible to prepare certain manuals of the equipment of NOAH when they are transferred in the future.

With regards to the manual for flood operation by means of the NOAH's stations, flood warning water levels shall be duly decided at key water level stations in the new river basins when the monitoring network is established in the target river basins.

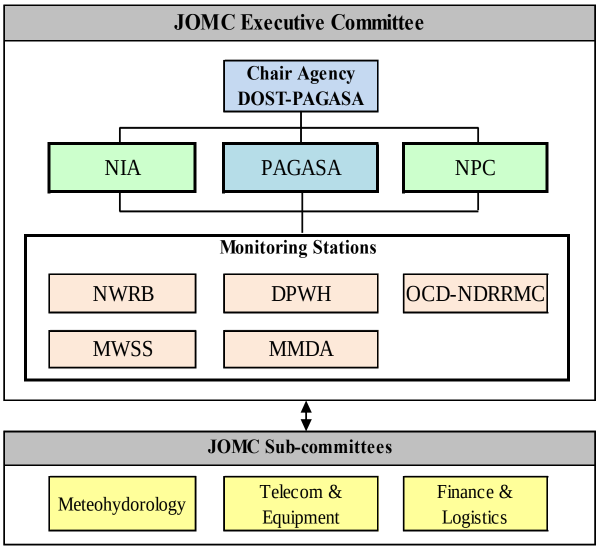
The Project NOAH is, meanwhile, conducting observation in 15 river basins (among the 19 target river basins) and distributed approximately 250 sites for rainfall, water level and weather stations. The data is sent through SMS to ASTI's server and uploaded on the web sites on real time basis.

8.2 Coordination System among Concerned Agencies

8.2.1 Current Status

(1) Joint Operation and Management Committee (JOMC)

The Joint Operation and Management Committee (JOMC) is the working committee responsible for the overall operation and management activities of the FFWS/ FFWSDO and is presently composed of PAGASA, NIA, NPC, OCD, NWRB, DPWH and MMDA. The basic structure was founded in 1992 in order to properly operate the FFWDO among the agencies concerned based on the Memorandum shown below:



Source: Study Team

Current Basic Structure of JOMC

The Administrator of PAGASA chairs the JOMC. There are three (3) sub committees which comprise the JOMC, namely, the sub-committees on (i) Hydrology (chaired by NWRB), (ii) Telecommunication (chaired by PAGASA) for operation and maintenance of the FFWS, and (iii) Finance and Logistics (jointly chaired by OCD and PAGASA) for financial and logistic matters in relation to the O&M of the FFWS/FFWSDO. Through the "Project for Strengthening of Flood Forecasting and Warning System for Dam Operation" by JICA (to be referred as “former JICA TCP”), a new sub-committee of “Dam Safety” was recommended. However, it has not been established as of the present date.

The former JICA TCP prepared the JOMC Strengthening Action Plan comprising 21 actions to be conducted by the member agencies. Among the actions, six (6) items have been completed under the former JICA TCP. The other 15 issues as listed below are on-going.

(1) Strengthen JOMC under the NDRRMC umbrella
(2) Update membership of JOMC and its subcommittees
(3) Establish regular meetings of JOMC
(4) Establish regular meetings of Sub-committees of JOMC
(5) Conduct regular assessment and planning workshops with sub-committees
(6) Strengthen the Finance/Logistic and Dam Safety Sub-committees
(7) Disseminate public information at downstream target areas
(8) Review/revise spilling protocols for a synchronized spilling operation of Angat, Ipo and Bustos Dams
(9) Review/revise Flood Operation Rule (FOR)
(10) Prepare/formulate telecommunication standards
(11) Formulate and install monitoring system
(12) Prepare future project proposals for strengthening of FFWSDO
(13) Conduct IEC of LGUs after every local election
(14) Conduct flood drills
(15) Train hydrologists and telecom engineers

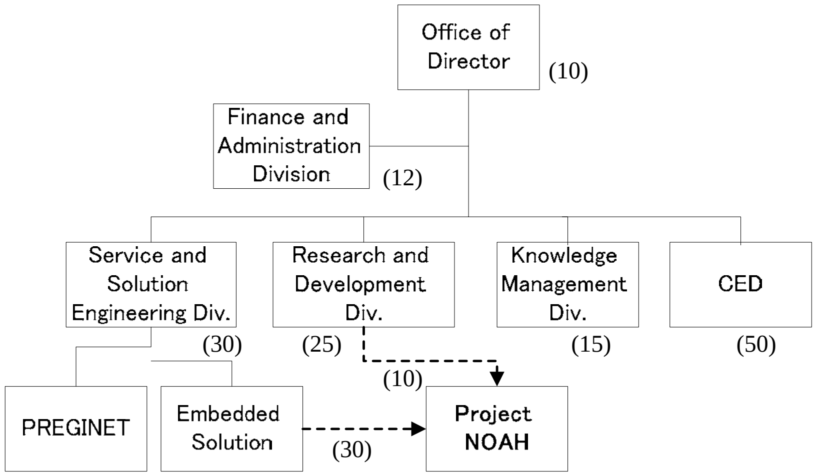
Coordination among the concerned member agencies of the JOMC has been improved through intensive joint activities such as flood runoff models/ hydrological database, flood drills and equipment O&M training, etc. As of September 2013 after completion of the former JICA TCP (November 2012), Hydormeteorological Sub-committee was held once in September, 2013.

Further, in accordance with the interviews to HMD staff, JOMC is not effectively utilized as interface for sharing the information of FFWS activities such as the Ready, Resilience, Twin Phoenix and NOAH Projects, etc. nowadays after the completion of the former JICA TCP. It is highly recommended to use the function of JOMC as interface for discussions and sharing the latest issues on FFWS/FFWSDO among the agencies concerned.

(2) Project NOAH

For implementation of the Project NOAH, approximately total 40 persons are working in Advanced Science and Technology Institution (ASTI) – DOST as of September 2013. However, these staff is all assigned as part time workers to the Project NOAH. Further, any particular division, which is responsible in operation and maintenance of the monitoring equipment, has not yet been organized in ASTI.

The current organization structure is illustrated as below:



Note: ( ), Number of staff
Source: Prepared by Study Team based on the information of ASTI-DOST

Organization Structure of Project NOAH in ASTI

8.2.2 Crucial Issues and Future Development

(1) River basins with existing FFWS (Cagayan, Agno and Pampanga)

The coordination among the agencies concerned regarding dam discharge warning is managed based on the output of the former JICA TCP for three (3) river basins as specified above. It is practical to continue and realize the recommendation in order to properly sustain the current coordination system among the agencies.

(2) Bicol River basin

Coordination system shall be discussed along with the progress of the "Project for Strengthening of Flood Forecasting and Warning System in the Bicol River Basin" (Non-project type grant of GOJ). The Project is scheduled to be completed within 2013.

In order to smoothly launch the monitoring services in the basin, the River Center under PRSD needs to be strengthened in both technical and organizational aspects. It is highly recommended that HMD will conduct more interventions, in particular during the initial stage right after the installation of the new equipment.

(3) Pasig-Marikina River basin

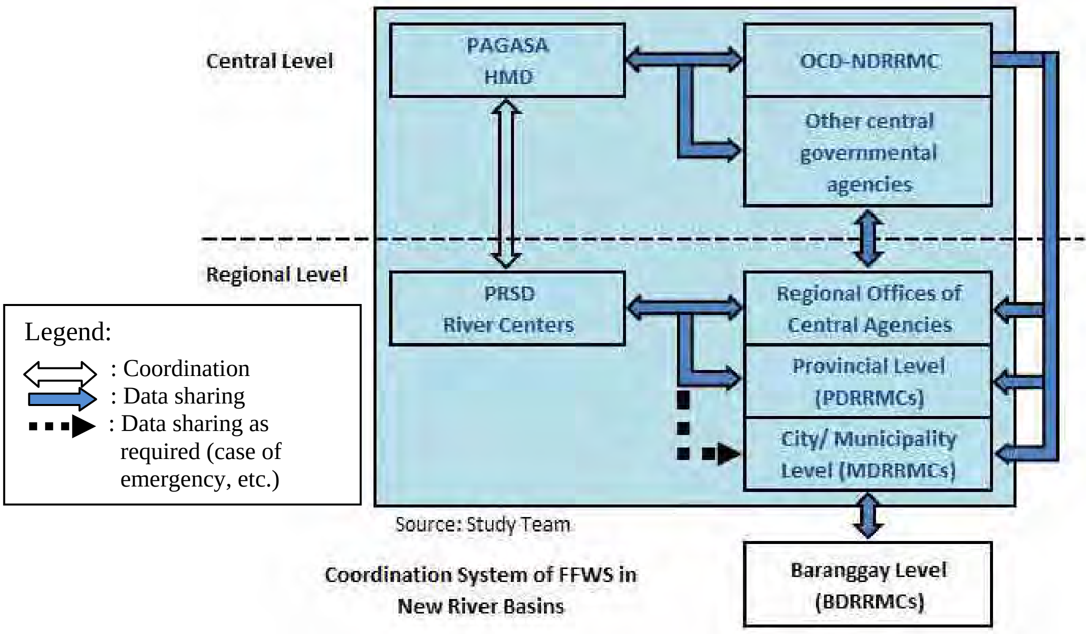
In the case of the Pasig-Marikina River basin, EFCOS is envisaged to rehabilitate and/or renew in the near future, considering the integration of KOICA system which will be transferred to PAGASA soon. Therefore, the coordination system shall be affected by the system configuration in the future.

On the other hand, even within PAGASA, close coordination and clear task demarcation between HMD and PRSD-NCR will be required in order to properly manage the overall system in the Pasig-Marikina FFWS.

(4) New river basins

It was verified through interviews with the PAGASA Staff that JOMC will be responsible in the future for handling and coping with the issues related to FFWS/FFWSDO in the Country. Therefore, it is obvious that the strengthening of JOMC will still be crucial for the creation of a better coordination system among the agencies. In this context, JOMC should be further strengthened through the conduct of the JOMC Strengthening Action Plan prepared by the former JICA TCP. This could be done with appropriate updating and rearrangement through the evaluation during the JOMC Execom. and/or Sub-committee meetings.

In particular, for future development of FFWS in new river basins, the coordination among PAGASA HMD, OCD-NDRRMC and other central government agencies is essential at the central level to maintain consistency. On the other hand, as seen in the existing five (5) river basins, coordination among PRSD (River Centers), regional offices of central government agencies, and LGUs is important. Involvement up to the city/municipal levels in the coordination system shall be principally considered based on the detailed conditions. Further, the coordination with Barangays concerned will be covered by the regional communication network of OCD.



Source: Study Team

The PAGASA HMD reported through interviews, in the Tagum-Libuganon River basin, the Provincial Government (Davao del Norte) manifesto support for the construction of the new river center. In fact, they offered a piece of public land to PAGASA at no cost for the river center. PAGASA should further consolidate and strengthen such partnership with LGUs in order to smoothly implement FFWS in the target new river basins.

In case of the Agusan River basin, a staff of PAGASA HMD conducted site reconnaissance to select candidate sites for NOAH’s gauging stations in April 2013. PAGASA HMD mentioned that the PDRRMC of Agusan del Sur as well as DOST CARAGA Region showed keen interest in establishment of hydrological network and subsequent monitoring works. It is expected that favorable relationship between the LGUs and PAGASA/DOST would be created for smooth installation works of the gauging stations including sharing of associated costs between PAGASA and LGUs.

As seen in the above, PAGASA is currently strengthening the relationship with provincial/ municipal governments (and/or LDRRMCs) to facilitate the construction of river centers, which will play important roles as monitoring hub in the respective river basins. Aside from the Tagum-Libuganon and Agusan River basins as abovementioned, PAGASA will commence construction of river centers at Cotabato in the Mindanao and General Santos in the Buayan-Malungon River basins respectively.

CHAPTER 9 CURRENT STATUS AND ISSUES TO BE SOLVED ON COMMUNICATION SYSTEM AND EQUIPMENT

9.1 Existing System and Equipment for Meteorological/Hydrological Monitoring

9.1.1 Line up of Existing FFWS and FFWSDO

The existing systems and equipments for the meteorological/hydrological monitoring in PAGASA, as described in Section 8.1, are categorized as follows:

- Data collection system
- Data transmission system

The data collection system consists of the equipments/facilities to measure rainfall/water level/weather at the observation sites and to transmit such data to the River Center/PRSD (PAGASA Regional Service Division) through VHF radio and GMS-SMS; i.e., telemetry/ automatic and telecommunication system.

The following seven data collection systems have been established, and details are described in the subsequent clauses:

(1) Measurement of rainfall and water level in Pampanga, Agno, Bicol, and Cagayan River basins, called "PAGASA FFWS";

(2) Measurement of rainfall and water level in Magat, Ambuklao, Binga, San Roque, Pantabangan, and Angat dams, called "FFWSDO"; their operation is the responsibility of NIA and NPC respectively,

(3) Measurement of rainfall and water level in Pasig-Marikina River basins, called "EFOCS", fall under the MMDA operation;

(4) Measurement of rainfall and water level in Ipo, La Mesa, and Angat dams, called "Ipo Dam FFWS", is under the operation of MMWS and NPC;

(5) Measurement of rainfall and water level in Caliraya Dam is operated by CBK and NPC (called as "Caliraya FFWSDO");

(6) Measurement of rainfall and water level in Aurora with allied river, Jalaur River in Iloilo, and Agus-Lake Lanao watershed, called "KOICA-I" is under LGU management; and

(7) Measurement of rainfall and water level in Pasig-Marikina River basins, called "KOICA-II" is operated by PAGASA

The collected rainfall and water level data (real-time data) are utilized for the flood forecasting by HMD (Hydro-meteorology Division) in PAGASA.

In addition to the data collection system, rainfall observation by radars has been established in recent years by PAGASA (Ref: Section 10.3).

The data transmission system consists of the equipment to transmit the collected data from the River Centers/PRSD to PAGASA WFFC at Quezon City. The information is monitored, processed, and archived for flood forecasting and warning system and weather forecasting activities.

9.1.2 Current Status of FFWS in PAGASA

The flood forecasting and warning systems (FFWS) in PAGASA and MMDA have been established through the funding assistance of OECF/ JICA and KOICA. The inventory of systems including their current status is presented in the table below;

List of Existing FFWS Operated by PAGASA

System Name	Purpose of the System	River Basin	Completion Year (Fund)	Current Status
I) OECF/ JICA funded				
Pampanga FFWS	Flood forecasting and flood warning	Pampanga	1973 (JICA)	Improved in 2009
Agno, Bicol, and Cagayan FFWS (ABC system)	Flood forecasting and flood warning	Agno, Bicol, and Cagayan	1980 (OECF) Some were rehabilitated in 1994 (OECF)	Agno FFWS was improved in 2011.
EFCOS Phase I *	Inflow monitoring and flood warning	Pasig-Marikina	1993 (OECF)	Improved in 2009
EFCOS Phase II *	Improvement of EFCOS Phase I	Pasig-Marikina	2002 (JICA)	Some stations are not operational.
Pampanga FFWS	Improvement of the old FFWS	Pampanga	2009 (JICA)	Operational
Agno FFWS	Improvement of the old FFWS	Agno	2011 (JICA)	Operational
II) KOICA funded				
Early Warning System (KOICA-I)	Community-based FFWS	Aurora with allied rivers, Jalaur, and Agus- Lake Lanao	2009	Not operating efficiently
The Establishment of an Early Warning and Response System for Disaster Mitigation in Metro Manila (KOICA-II)	Flood forecasting and flood warning	Pasig-Marikina	2012	Operational

Note : *
The equipment/system of EFCOS Project has been operated and maintained by MMDA, and is not the responsibility of PAGASA.
Monitoring of the measured data from the EFCOS system at PAGASA WFFC was established in August 2012 under the GOP fund connecting a new communication link between Rosario master control station and OCD. The data was transmitted through 18 GHz wireless radio system, which was provided under the Project for Improvement of Flood Forecasting and Warning System in the Pampanga and Agno River Basins Phase I to connect NIA and OCD, from Rosario to OCD and through the existing PLDT data line from OCD to PAGASA WFFC.

Source: Study Team

(1) Projects by OECF/ JICA funded

The equipments of Pampanga and Agno FFWS under JICA fund (Grant Aid Project) are currently operational after completion of renovation in 2009 and 2011, respectively, with O & M works by PAGASA.

The equipment in the Bicol and Cagayan FFWS installed by OECF funds have deteriorated because their lifetime expired. Since the existing equipment of the Cagayan FFWS has been existent for more than 30 years, rehabilitation or improvement is urgently needed for proper operation (The equipment in Bicol FFWS will be improved by the Japanese ODA project).

On the other hand, operational conditions and situation of the EFCOS system was reviewed by the current Study in June 2013. The results are compiled in Appendix D. It has been 11 years since the completion of the previous rehabilitation works. Further detailed operational conditions of the equipment and facility need to be examined. In general, the lifetime of the computer hardware is considered approximately for 10 years and microwave system is approximately for 15 years, respectively.

Overall system of the FFWS and FFWSDO is shown in Figure 6.1.1. Overall operational conditions are shown in Appendix J and are enumerated in table below and:

Operational Conditions of FFWS as September 2013

System Name	Rainfall Gauging Stations (operational nos. /Total nos.)	Rainfall and Water Level Gauging Stations (operational nos./ Total nos.)
FFWS in Pampanga River basin	7/7	9/10
FFWS in Agno River basin	3/3	8/8
FFWS in Cagayan River basin	-	3/5
FFWS in Bicol River basin	2/3	2/6
EFOCS Phase II	4/7	8/11 (water level only)

Source: PAGASA HMD

(2) Projects funded by KOICA

The equipment for early warning system (EWS) supplied by KOICA-I Project is shown in the table below.

List of EWS Equipment under KOICA-I

Province	Aurora	Ilolio	Lanao
River basin	Aurora River and allied river basins	Jalaur River	Agus-Lake Lanao watershed
Rain gauge	4+1*	5	5
Water level/Tide	4/2	2	4
Evaporation	2	1	2
AWS	2	1	2
Installation place of Monitoring Station	Provincial Disaster Action Center (PDAC)	Provincial Disaster Action Center (PDAC)	NPC Mindanao-Generation Office
Remarks:*, for Science Garden at Quezon City			

Source: PAGASA HMD

The KOICA-I Project was designed to integrate telemetry system and for participation of the community (LGUs). Further, the short messaging system (SMS) was employed as a data transmission system between central processing center and monitoring stations. The center is operated by LGUs (Provincial Disaster Action Center). This set-up was based on the premise that the LGUs and the community must have a share in the operation of the system because they are in the position to cope with the flood hazard.

The current situation of the EWS equipments under KOICA-I Project is summarized as follows:

- The equipments at Aurora and allied river basins were demolished because these were dysfunctional, according to the information from PAGASA.
- It was reported by PAGASA in July 2012 that only one rain gauge and one AWS in the Jalaur River basin were operational (A total of nine gauging stations had been installed.).
- Detailed situations of operation of the EWS at the Agus-Lake Lanao watershed have not been reported to PAGASA, because the equipment was already handed over to the LGUs.

The KOICA-II Project was turned-over to PAGASA HMD in 2013 and the following have been observed:

- Some of the measured data are not reliable, e.g., temperature data of Pasig City Hall showed 15°C on 20 April 2013. The normal temperature in the Manila is 25-35°C in April.
- The measured data could not be transmitted at 10 minutes measurement interval (e.g., approximately two times per one hour, data are missing at many stations) even though the telecommunication system is a redundant system (main is VHF radio and back-up is GMS).
- Microwave radios have been used; 5 GHz radio band (wireless LAN) that is not a licensed band in the Philippines (everybody can use the band for free without permission from NTC).
- Three warning equipments out of ten were submerged in August 2012 and the equipment have not been repaired yet.

9.1.3 Current Status of Weather Monitoring System in PAGASA

The automatic measurement facilities for the meteorological data of PAGASA and other relevant data are enumerated as follows:

List of Automatic Weather Observation Facilities Operated by PAGASA (1/2)

Project Name	Component	Completion Set and Year	Current Status
Meteorological Telecommunication System (MTS) through funding aid from the OECF	Data transmission of the meteorological data and nationwide UHF radio communication (Manila to Mindanao)	1995	Not operational because of radio interference from cellular phone networks *
KOICA I Project	Automatic Weather Station (AWS)	4 sets in 2008	Not operating efficiently
TECO I Project (Taiwan fund)	AWS	2 sets in 2009	Operational
MWSS Project	AWS	2 sets in 2009	Operational
Mindanao Project	AWS	12 sets in 2010	Operational
Automation I Project	AWS	20 sets in 2010	Operational
TECO II Project	AWS	15 sets in 2011	Operational
MDGF Project	AWS	4 sets in 2011	Operational

Source: PAGASA METTSS/ ESTD

List of Automatic Weather Observation Facilities Operated by PAGASA (2/2)

Project Name	Component	Completion Set and Year	Current Status
Automation II Project	AWS	10 sets in 2012	Operational
KOICA II Project	AWS	4 sets in 2012	Operational, but some data are not reliable
JAMSTEC Project	AWS	2 sets	Operational
Hong Kong Co-Win Project	AWS	1 set	(No Information)
SMART Co-location	Automatic Rain Gauge (ARG)	75 sets	Operational
KOICA -II	ARG	10 sets	Operational
Montalban	ARG	1 set	Operational
TECO I- Tayabas	ARG	1 set	Operational
Note: Since usage of the cellular phone networks in the Philippines was permitted in the mid 1990's by NTC, the 800 MHz UHF radio equipment used in MTS has experienced interferences from the cellular phone due to usage of same frequency band (800 MHz). As the result of expanded usage of cellular phones nationwide, the quality of data transmission by the 800 UHF radio has deteriorated.			

Source: PAGASA METTSS/ ESTD

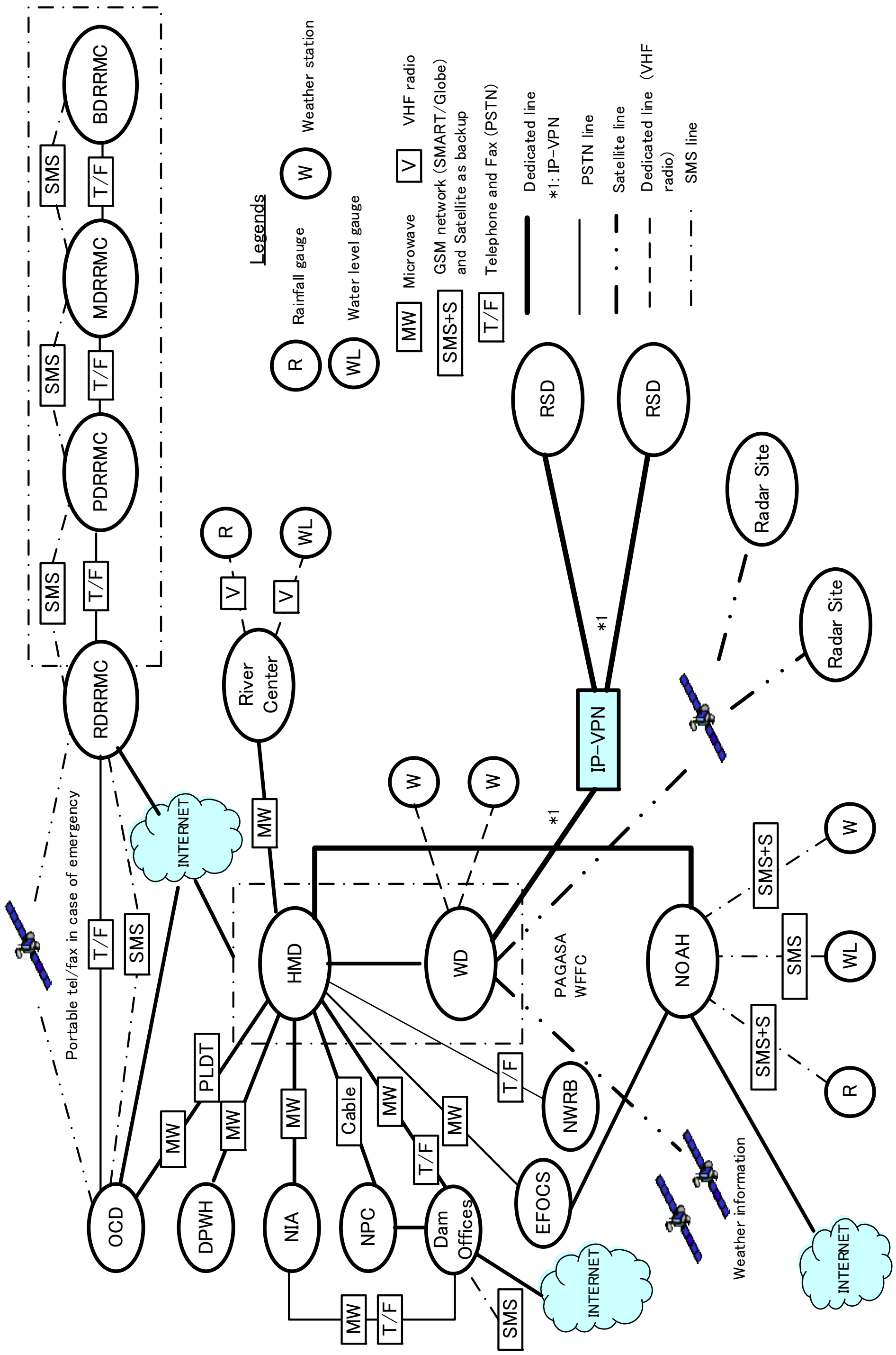
There are 75 sets of AWS, excluding one set from the Hong Kong Co-Win Project, and 87 sets of ARG in PAGASA. In addition, ASTI established 100 sets of AWS, 80 sets of ARG, and about 67-74 sets of water level stations (WLS) as of 17 January 2013.

Since these equipments have been newly installed, most of them are still in operational condition except the KOICA-I Project.

The outline of the current telecommunication systems for the FFWS and weather monitoring system is described below:

- Telecommunication equipment between river centers and rainfall/water level gauging stations is a dedicated VHF (150 MHz) radio to transmit the rainfall/water level data. This is a reliable and robust communication process.
- Telecommunication equipments between HMD and the relevant agencies (OCD, DPWH, NIA, NPC) for flood disaster risk management activities consist of dedicated link with 7.5 GHz microwave radio or optic fiber cable, which are reliable and robust as backbone network,
- Public switched telephone network (PSTN), namely telephone and facsimile lines provided by a telephone carrier (PLDT and/or GLOBE companies in the Philippines), has been used as main network instead of the 7.5 GHz microwave radio (the dedicated line), among HMD, NWRB, and some of the dam offices (ex. Magat and Angat dams),
- Cellular phone is used as verbal communication and short message service (SMS) or as text messaging,
- SMS through the cellular phone as main communication link with backup by a satellite data link (except water level measurement) is used for transmission of weather data between NOAH and observation stations,
- IP-VPN provided by the telephone carrier is used between NOAH and EFCOS data link,

- IP-VPN is also utilized as data transmission of the processed weather data, namely combination of weather data and radar data between WD and RSD,
- Radar data from the sites have transmitted with satellite communications,
- Satellite communications also have been used for Global Telecommunication System (GTS), and marine observation, WMO World Information System (WIS) as international weather data exchange.



Source: Study Team

Schematic Diagram of Telecommunication Systems for FFWS and Connectivity with Weather Monitoring System

9.1.4 Current Status of Equipment on FFWSDO

The equipments of FFWSDOs in NIA and NPC were established through funding aid from OECF and through national government fund. Their current status is reflected in the following table. Overall system of the FFWSDO excluding Ipo dam and Caliraya dam is shown in Figure 6.1.1.

List of Existing FFWSDO

System Name (Operator)	Purpose of the System (Finance)	Dam/ River Basin	Completion Year	Current Status
FFWSDO-I (Angat: NPC Pantabangan: NIA)	Inflow forecasting and dam flood warning (OECF)	Angat/Angat and Pantabangan /Pampanga River	1986	Operational, but some of them are not operated.
FFWSDO-II (Binga and Ambuklao: NPC Magat: NIA)	Inflow forecasting and dam flood warning (OECF)	Binga and Ambuklao/ Agno and Magat/ Magat River	1994	Operational, but some of them are not operated.
San Roque Telemetry System (NPC)	Inflow monitoring (OECF)	San Roque dam/ Agno River	2004	Non-operational
Ipo Dam Flood Forecasting System (NPC/MWSS)	Monitoring and flood warning (MWSS-GOP)	Ipo/Angat/ La Mesa Dam/ Angat River	2012	No monitoring from PAGASA
Caliraya FFWSDO (NPC/ CBK)	Monitoring and flood warning (GOP)	Caliraya Dam	2013	Some of them are not operated and functional.

Source: Study Team

The equipments provided under the San Roque telemetry system have not been functional due to reasons stated below. Further, the systems have not been repaired yet due to the financial problems of NPC.

- Radio repeater equipment at Mt. Ampucao repeater station has been damaged by lightning in 2007.
- Computer system at NPC San Roque has been malfunctioning.

In view of the equipment aspect, the following items have been provided under “The Project for Strengthening of Flood Forecasting and Warning System for Dam Operation” as enumerated in the table below:

Equipment Procured by the Former JICA TCP (1/2)

Package No.	Description of the Procurement Packages	Completion	Installation Place
1	Power Supply Equipment for the “Transfer of the Existing Warning Equipment from Binga to San Roque Dam”	March 2011	San Roque FFWSDO Office (NPC)
2	Equipment: Water Level Telemetry Sub-system	July 2011	Magat, Maris, Ambuklao, Binga, San Roque, Pantabangan, Masiway, Ipo, and Angat dams
3	Data Interface in Binga Dam and Software Modification at the PAGASA WFFC	February 2012	Binga Dam and PAGASA WFFC

Source: Study Team

Equipment Procured by the Former JICA TCP (2/2)

Package No.	Description of the Procurement Packages	Completion	Installation Place
4	Data Transmission System from Pantabangan Dam to PAGASA WFFC	March 2012	Pantabangan Dam and PAGASA WFFC
5	Procurement of Spare Parts for the Water Level Telemtery Sub-system (No. 2)	February 2012	One unit of water level equipment has been used for Pantabangan Dam. Another one is stored at the PAGASA WFFC.
6	Procurement of Portable Testing Instruments	November 2012	PAGASA, Magat Dam, Pantabangan Dam, and NPC H/Q

Source: Study Team

The following work items have been conducted by PAGASA through funding from the GOP in 2012:

- Three components consisting of (i) transfer of the existing 18 GHz wireless radio equipments for establishment of the communication link of EFCOS (Rosario Master Control Station) – OCD, which were previously installed for the NIA – OCD communication link by the grant aid project of Japan, (ii) provision of monitoring facility to PAGASA WFFC, and (iii) renewal of the server system at Rosario master control station; consequently, PAGASA can monitor rainfall and water levels in the Pasig-Marikina River basin.
- Data transfer of FFWS data of the Pampanga and Agno River basins to ASTI; this is referred to as "FFWS Data Aggregator Program."
- Data transmission system of weather data by IP-VPN with PLDT communication line, which connects 19 places, such as PAGASA WFFC, PRSD, and Radar sites. The detail is described in Section 9.5.

Overall operational conditions are shown in Appendix J and are enumerated in the table below:

Operational Conditions of FFWDO as of September 2013

System Name	Rainfall Station in the Upper Stream (Operational No. / Total No.)	Water Level Station in the Upper Stream (Operational No./ Total No.)	Warning Station in the Downstream (Operational No./ Total No.)
FFWSDO in Magat Dam	**4/6 *1 & 6/6 *2**	**1/2 *1 & 4/4 *2**	**11/15 *1 & 6/6 *3**
FFWSDO in Pantabangan Dam	**5/5 *4**	**1/2**	**17/19**
FFWSDO in Binga & Ambuklao Dams	**4/4**	**2/2**	**-**
FFWSDO in San Roque Dam	**0/1 *5**	**0/1 & *5 1/1 (dam)**	**16/18**
FFWSDO in Angat Dam	**3/4**	**1/3 (dam)**	**17/17**

*1: VHF radio telemetry stations by OECF
*2: Satellite and SMS telemetry stations by NIA
*3: Public warning system by NIA
*4: VHF radio telemetry station by NIA, but the data have not transmitted to PAGASA automatically
*5: VHF radio telemetry station by NPC

Source: Study Team

9.1.5 Current Status on Components of Project NOAH

Considering the equipment aspect, distribution of hydrometreological devices in hard-hit areas in the Philippines is the main object of the Project NOAH. A total of 600 automatic rain gauges (ARG) and automatic weather stations (AWS), and 400 water level monitoring stations (WLMS) would be installed in the 18 major river basins by December 2013.

Since detailed information/ specifications of the equipment for ARG and WLMS were not obtained, the following information was gathered through interviews and surfing the internet:

a) Sensors and instruments which measure wind speed/ direction, air temperature, pressure, humidity, and rainfall are imported from foreign countries (Vaisala in Finland, Davis Rain Collector in U.S.A., etc.).
b) Data logger/controller is designed by ASTI and manufactured in the Philippines by Alex Sun Electronics.
c) There are two ways of transferring data, i.e., by SMS through GSM (local product), and satellite (Iridium) as back-up in the case that data cannot be sent through SMS.
d) WLMS adopts an ultrasonic type sensor which is imported from a foreign country. The detection range is up to 15 m. Data can be sent only through SMS.
e) Solar cell panel and storage battery can provide power in case of blackout. The duration of power supply is approximately two weeks.

9.1.6 Future Development Plans by PAGASA, NGCP, and PLDT

(1) PAGASA

There are future development plans of providing equipment/ facilities as follows:

- KOICA Project: Establishment of seven ARG and two WLS in the Cagayan de Oro River basin
- Non-project type of grant aid by the Government of Japan in 2013: Provision of sensors such as rain gauge, water level gauges and others in the Davao River basin (the details of the Project will be determined later)
- Feasibility study for the Meteorological and Hydrological Telecommunications System Upgrade Project was made under the USTDA grant aid and the Final Report was issued in March 2012. The study has covered the followings:
  - Construction of new backbone microwave radio links with a redundant system nationwide, connecting Northern Luzon to Mindanao islands, and
  - Provision of new satellite telemetry system instead of VHF radio data links.

  According to the information from PAGASA, there is no plan to implement the feasibility study. PAGASA intends to utilize the existing or new NGCP's network, which consists of reliable optic fiber and microwave radio system.

(2) ASTI

- Project NOAH: Remaining ARG/ AWS/ Water level stations (approximately. 750 sets) by the end of year 2013

(3) NGCP

Power extension project "Leyte-Mindanao Interconnection Plan (LMIP)" by NGCP, is briefed as follows:

- Power grid extension from Luzon to Mindanao by way of Visayas power grid, which is under progress, will be completed by 2018 laying 23 km submarine cable;
- Long transmission line from Surigao to Cagayan de Oro in Mindanao will be constructed;
- A new telecommunication system, consisting of optic fiber or microwave radio, will be constructed along the power grid; and
- Total project cost is estimated to be 500 million US dollars.

PAGASA has experience in borrowing the telecommunication facility from NGCP in the Pampanga/Agno FFWS project. In the same way, PAGASA can use the communication link of NGCP as the backbone line between PAGASA WFFC and the new river centers in the Mindanao. The river centers mentioned below can be connected after year 2018:

- Agusan River basin
- Tagoloan River basin
- Cagayan de Oro River basin

As another future extension scheme is not planned by NGCP at the present time, PAGASA need to plan another scheme such as a satellite communication or new micro-wave radio system, connecting to the above NGCP network for the following selected river basins:

- Tagum-Libuganon River basin
- Davao River basin
- Mindanao (Cotabato) River basin
- Buayan Malungon River basin

In case of the Jalaur River basin, PAGASA need to establish its own communication link.

(4) PLDT

According to a PLDT publication in June 2013, the company has already started to put up two fiber optic submarine cables, Bohol - Cebu and Bohol - Cagayan de Oro. In addition to the above NGCP network, PAGASA may also be able to utilize the new fiber optic cable for the data communication in the near future.

9.1.7 Crucial Issues from View of Equipment Operation

(1) KOICA-II

As described in Clause 9.1.2, there are several problems on operation of the system. Verification of the system is necessary.

(2) Project NOAH

Purpose of measurement of the precipitation/rainfall is same between PAGASA FFWS and NOAH project, but normal measurement time interval is different from each other, namely 30/60 minutes interval in PAGASA WFFS (10 minutes interval by manual operation is possible) and 10/15 minutes interval in NOAH project.

Difference in the measurement of the water level in the river is emulated as follows:

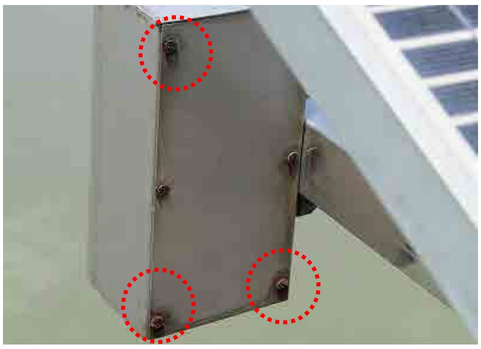
- PAGASA FFWS: To measure water level and estimate discharge accurately (in case of pressure type water level sensor with accuracy of +/- 2 cm for 20 m measurement range)
- Project NOAH: To detect floods, high accuracy is not required (NOAH does not disclose the accuracy of measurement)

Regarding to the standards/specifications of the equipment, the standards applied in PAGASA WFFS are based on Japanese standards and design codes used in Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan. Meanwhile, the standard or code used in the NOAH project are not clear.

The Study Team conducted a site survey on the existing stations (Tumana Bridge WLMS and Napindan ARG/ WLMS) along the Pasig-Marikina River and observed the following as depicted by the subsequent pictures below:

- Equipment is susceptible to vandalism because there is no fence to serve as protection.
- Water level sensor would be prone to rusting due to water penetration.

Pictures of NOAH Project

<table>
<tr><td>
</td><td>
</td></tr>
<tr><td>Tumana Bridge WLMS
- No fence
- The water level sensor is affected by vibration from the bridge slab.</td><td>Tumana Bridge WLMS
- No keypad inside the box.
- Cable is exposed to the sun.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Napindan
- No fence
- Tipping unit has been stolen.</td><td>Napindan
- Rusting has already occurred (water has penetrated inside).</td></tr>
</table>

Source: Study Team

Status of the equipment used in NOAH project should be watched carefully for some duration, i.e., verification of the measurement data should be conducted comparing the manual record data. In addition, the design code or standardization of the equipment shall be established for FFWS activity in the Philippines.

(3) Telemetry stations in the existing FFWSDO

As stated above, there are some non-operational telemetry and warning stations in the FFDSDO. Therefore, their rehabilitation or improvement shall be required for proper operation of FFWSDO.

(4) Existing backbone telecommunication network

Backbone telecommunication network for PAGASA WFFC and Tuguegarao sub-center/Magat Dam office shall be rehabilitated. In related, backbone telecommunication network between Aparri radar site and Tuguegarao sub-center/Magat Dam office shall also be considered.

(5) Utilization of the existing FFWS

The telemetry data of the existing FFWS has not effectively been utilized in HMD, in particular, data sharing and data archiving (ineffective use of monthly reporting function of the WEB server at WFFC) among PAGASA, which can be distributed to the relevant agencies as static record. In addition, present HMD/FFWS seems to be lacking knowledge of system operation and of modification of computer program for the flood warning water levels (Alert and Critical WL) and H-Q calculations.

9.2 Operation and Maintenance of Existing Equipment

9.2.1 Current Status

Organizationally, the operation and maintenance of the PAGASA owned communication equipment/ facilities for FFW operation is administrated by HMTS and each river center.

Operation and maintenance of the equipment/facilities owned by other agencies (NIA/NPC/MMDA/CBK) are the responsibility of each agency concerned.

(1) PAGASA HMTS

The HMTS conducts the regular maintenance works (four times per year) on the existing FFWS. The latest maintenance works are enumerated below:

- Pampanga River Basin: December 2012
- Agno River Basin: January 2013
- Bicol Basin: January 2013
- Cagayan River Basin: February 2013

PAGASA HMTS has reported the following accidents recently, and operation and maintenance works on the telemetry system and communication system have undertaken properly by PAGASA HMTS. The works should be continued for future with employment of young engineers and technicians.

- Remedial works on Peñaranda station in the Pampanga River Basin was conducted on 14 August 2012. The cause of the problem was the destruction of the water level signal cable and grounding cables by a rat.
- The transmission of water level data from Mayapyap station of Pampanga FFWS has been stopped since 20 July 2013 to date due to vandalism (a door of the gauging house was opened). Since the water is high during the rainy season, it is difficult to check the water level sensor at the site. In principle whenever troubles occur with the water level sensor or sensor cable, PAGASA needs to investigate the cause of the problem so as to remedy it immediately.

(2) PAGASA ETSD

Regarding the AWS and ARG of Engineering and Technical Services Division (ETSD), no maintenance works have been done since their installation. According to ETSD, since these equipments have just been installed in 2008, maintenance works are still not required. There is neither inventory list nor maintenance record.

The ETSD has decided that maintenance works would be sublet to a private company starting this year.

(3) Project NOAH

Although, it is reported that the equipment of ASTI will be transferred to PAGASA, it has not been formalized yet according to PAGASA HMD.

9.2.2 Crucial Issues

(1) Data Server and Other Computer System

Operation and maintenance work on the data server and other computer system through computer/ software and IP network technologies should be strengthened (HTMS staff seems to have insufficient knowledge regarding computer and IP network technologies).

The O & M work for the computer/ software and IP network would be outsourced because such facilities would be utilized not only in HMD, but in many sections of PAGASA and up-to-date knowledge are required for proper operation and maintenance.

(2) Project NOAH

If ASTI's equipments are transferred to PAGASA, the HMD has to increase the number of its staff in order to efficiently operate and maintain the said equipment. The personnel assigned to the operations and maintenance (O&M) shall be deployed to each river center.

9.3 Transmission and Dissemination of Flood Information

9.3.1 Categories of Flood Information Released from PAGASA/HMD

(1) Flood Information for telemetered river basins, namely the Pampanga, Agno, Bicol and Cagayan (PABC)

According to the "Operation Manual for the Flood Forecasting and Warning System of the River Basin updated in October, 2012", the flood information is classified into the following five categories;

- Basin Flood Bulletins (1)

The Basin Flood Bulletins provide information in the form of warnings, issued to major river basins provided with telemeters and dam target areas, prior to and during flood periods. These are being issued by the respective river centers for PABC.

- Basin General Flood Advisory (2)

General Flood Advisory provides basic hydrological information. It is issued during flood watch periods for the awareness and preparedness of the inhabitants in areas likely to be affected by river/flash flooding.

The Basin General Flood Advisory is prepared and issued by RFFWC as initial basin flood information. The rivers concerned are confined to the telemetered or gauged river basins.

- Region General Flood Advisory (3)

Principally the same as the above, the Region General Flood Advisory is prepared and issued by HMD. The concerned rivers are not confined within a political region, extending to the rivers in Pampanga, Agno, Bicol, and Cagayan.

- Basin Hydrological Forecast (4)

The Basin Hydrological Forecast provides information to interested parties on the hydrological conditions of the rivers being serviced during non-flood watch period.

- Dam Hydrological Situationer (5)

The Dam Hydrological Situationer provides information on the current hydrological status of the major dam being serviced. It is uploaded daily on the PAGASA website by the MOC (FFWS) as PAGASA's participation in the inter-agency FFWSDO.

The flood information issued for the dam operation follows standard forms as stipulated below in conformity with the "Updated Flood Warning Manual for Dam Target Areas" of November 2012.

Standard Forms for Dam Discharge Warnings

No.	Format	Title	Sender	Recipient
(A)	FWO-FORM 1	Commencement of Flood Precaution Period	PAGASA/HMD	FFWS Dam Office, PDRRMC, PAGASA Sub-Center
(B)	FWO-FORM 2	Report on Commencement of Flood Precaution Period	FFWS Dam Office	PDRRMC, PAGASA Sub-Center
(C)	FWO-FORM 3	Flood Information	PAGASA/HMD	FFWS Dam Office, PDRRMC, PAGASA Sub-Center
(D)	FWO-FORM 4	Termination of Flood Warning Operation	PAGASA/HMD	FFWS Dam Office, PDRRMC, PAGASA Sub-Center

Source: "Updated Flood Warning Manual for Dam Target Areas, Nov. 2012"

(2) Flood Information for River Basins provided with telemeters in PABC

The sub-centers in PABC have been established and operational and they are responsible for the issuance of the Basin Bulletin (1) and Basin Flood Advisory (2). With the rehabilitation of the Pampanga and Agno FFWS in 2009 and 2011, respectively, dedicated communication lines between the PAGASA/HMD-MOC were restored using microwave or fiber optic links. For Bicol and Cagayan, public lines (PLDT) and internet are used for communications with the HMD-MOC. The Basin Bulletin (1) and Basin Flood Advisory (2) of the above category are issued by the Sub-Centers to the PAGASA/HMD, who in turn, transmits it to the NDRRMC. In the same manner, the Sub-Centers, which are responsible for collecting telemetered data on river water levels and the amount of rainfall and issuing flood information of the above category, also do parallel dissemination to the local P/M/C/BDRRMC as well as to the TV/radio media.

(3) Flood Information for River Basins in the Pasig and Laguna de Bay

The Telemeter System, operational under the Effective Flood Control Operation System (EFCOS), is managed and controlled by the Metro Manila Development Authority (MMDA). Currently MMDA is responsible for issuing flood warning information to the concerned government agencies such as OCD-NDRRMC, PDRRMC, and other LGUs. PAGASA/HMD has no authority to manage and control the system. It receives and monitors information from the MMDA.

(4) Flood Information for River Basins without FFWS (ungauged or non-telemetered river basin)

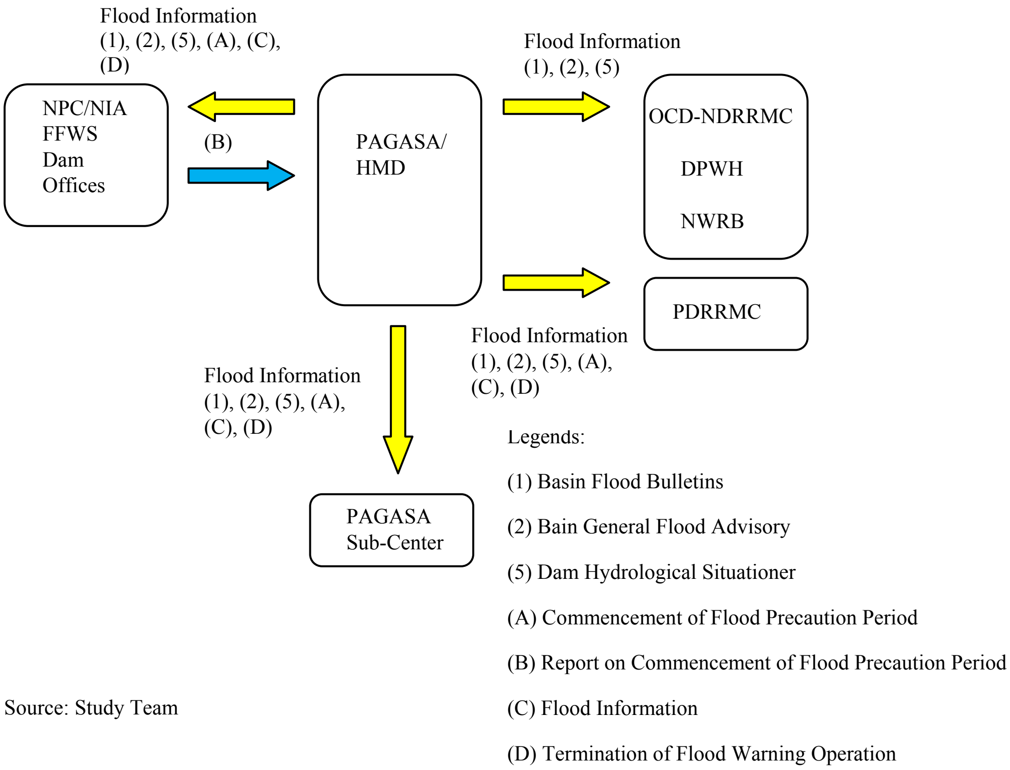
There are five (5) PAGASA Regional Services Divisions (PRSD), namely Northern Luzon PRSD, Southern Luzon PRSD, NCR PRSD, Visayas PRSD and Mindanao PRSD. Based on the synoptic data as well as data collected from ASTI website, PAGASA/HMD issues the flood information to the non-telemetered river basins and these are disseminated to the NDRRMC and the corresponding PRSDs and to some extent, the PDRRMCs. However, the Region Flood advisory category (4) is the only information that PAGASA/HMD can afford.

9.3.2 Flow Process of Flood Information Released by PAGASA/HMD

The flow process of the flood information is not the same in all the rivers concerned. Some river basins in Agno and Pampanga are dam-controlled. There is a dedicated communications system in operation among the concerned offices such as NPC/NIA Dam Office, PAGASA Sub-Center, etc. There is no such communication system for other rivers without dam operation, so the transmission of flood information released from PAGASA/HMD is quite limited. Current transmission processes of flood information for the respective rivers are described below.

(1) Transmission of Flood Information for the river basins in Agno and Pampanga

The picture below shows the flow process of flood information from PAGASA/HMD to the concerned agencies. The river basins in Agno and Pampanga are provided with a dedicated communications system enabling real-time monitoring of the river basins and utilizing FAX/TEL on VOIP lines. Flood related information exchanged among the concerned offices are information categories (1), (2), (5), (A), (B), (C), (D) mentioned in the previous Clause 9.3.1. The overall process diagram is attached in the List of Figures. Refer to the Figure 9.3.1 for Dam Discharge Warning Network in Agno River Basin as an example.

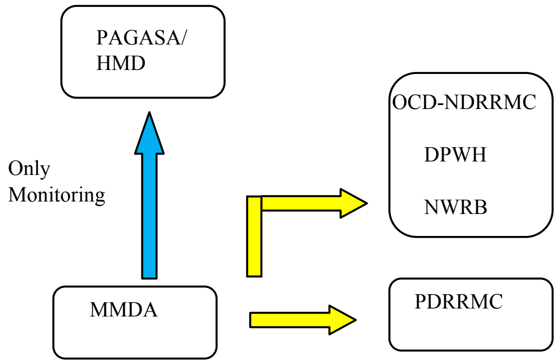


Source: Study Team

Transmission of Flood Information for Telemeter-Provided Rivers in Pampanga, Agno

(2) Transmission of Flood Information for the river basins in Pasig-Laguna de Bay

As described in the paragraph above, MMDA Rosario Office is responsible for issuing the flood information. PAGASA/HMD is limited to monitoring the information released by the MMDA Rosario Office and does not produce any flood information. Instead MMDA Rosario Office issues its own flood information to the concerned agencies. The overall process diagram is attached in the List of Figures. Refer to Figure 9.3.2 for Flood Warning Information Network in Pasig-Laguna de Bay River Basin.

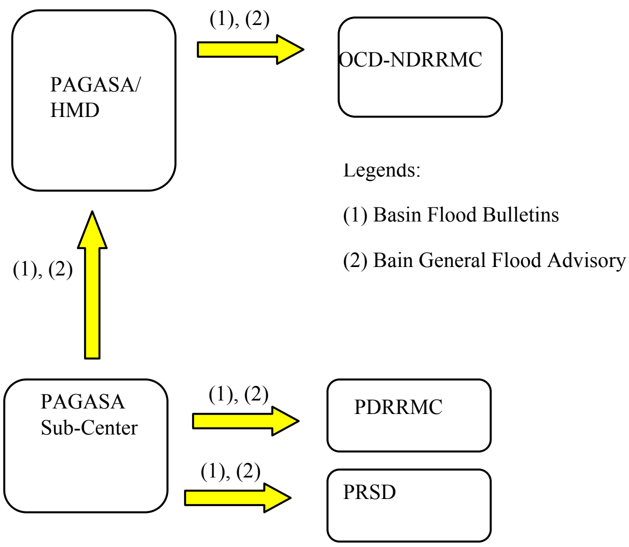


Source: Study Team

Transmission of Flood Information for Rivers Provided with Telemeters in Pasig and Laguna de Bay

(3) Transmission of Flood Information for the river basins in Bicol and Cagayan

There are PAGASA Sub-Centers for the river basins in the Bicol and Cagayan. However, they do not have dedicated communications link between PAGASA/HMD and the Sub-Centers. The Sub-Centers produce the flood information instead of PAGASA/HMD in accordance with categories (1) and (2) since it is mandatory to release the earliest flood information to the local residents. According to the staff of the Sub-Center, there are instances, especially during inclement weather condition, that communications to PAGASA/HMD are very difficult. The overall process diagram is attached in the List of Figures. Refer to the Figure 9.3.3 for Flood Warning Information Network in Bicol and Cagayan River Basins.

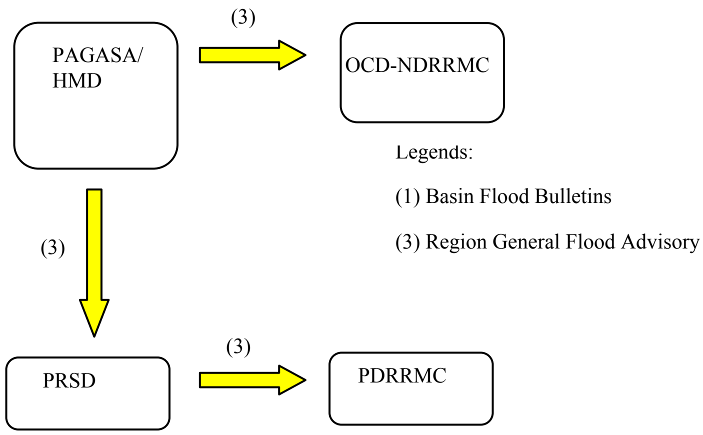


Source: Study Team

Transmission of Flood Information for Rivers Provided with Telemeters in Bicol and Cagayan

(4) Transmission of Flood Information for the Other River Basins without FFWS

The Regional Flood Advisory, category (3) is the only information released to the PRSD when heavy rainfall is forecasted or a typhoon is imminent. However, the information is simple and without detail. Currently, PAGASA/HMD does not have a system of real-time monitoring, therefore weather data collected by PAGASA/HMD are the only information utilized in the preparation of the Regional Flood Advisory. Accordingly, they cannot afford to provide more detailed information of the expected flooding. Likewise, the Regional Flood Advisory is also transmitted to the concerned PRSD.



Source: Study Team

Transmission of Flood Information for Rivers without Telemeters

As described in the previous paragraphs, there are five PRSDs nationwide. The PRSDs responsible for the target 14 rivers without FFWS are tabulated as follows. The Chief Meteorological Officers stationed at PRSD are also members of PDRRMC and are provided with office mobile phones by PAGASA to be used for receiving SMS from PAGASA/HMD.

River Basins under PRSD Responsibility

PRSD	Rivers without FFWS
PRSD Northern Luzon (Tuguegarao)	Abra River Basin
	Abulog River Basin
PRSD V Visayas (Mactan/Cebu)	Panay River Basin
	Jalaur River Basin
	Ilog-Hilabangan River Basin
PRSD Mindano (Cagayang de Oro)	Agusan river Basin
	Agus-Lake Lanao River Basin
	Buayan-Malungon River Basin
	Cagayan de Oro River Basin
	Mindanao River Basin
	Davao River Basin
	Tagoloan River Basin
	Tagum-Libuganon River Basin
	Mandulog River Basin

Source: Study Team

The overall process diagram is attached in the List of Figures. Refer to Figure 9.3.4, Flood Warning Information Network in River Basins without FFWS.

9.3.3 Methods for Flood Information Released from PAGASA/HMD

There are four methods of communications currently used by PAGASA/HMD to distribute Flood Information to their Sub-Centers, related government agencies, etc. In river basins with Dam Operation, there is a dedicated communications system with hot-line telephone and FAX or VOIP FAX/TEL with the concerned agencies. Where there is no dedicated communications system, the public telephone and FAX are used along with SMS, E-Mail, and Internet Web for redundancy.

(1) Public Line FAX/TEL

Except for the river basins in Agno and Pampanga which have dedicated communications networks, the public line FAX/TEL is commonly used as communication equipment between PAGASA/HMD and Sub-Centers, PRSD, and other government agencies. According to the interview at Tuguegarao Sub-Center, the staff mentioned that the connectivity is down during heavy rains and storms.

(2) VOIP FAX/TEL (Hot-Line Telephone)

They are available for the river basins in Agno and Pampanga. Unlike the public lines, the connections are reliable without the problems mentioned above.

(3) Short Message Service (SMS)

For the transmission of Flood Information, SMS is often used simultaneously with the public line TEL/FAX for redundancy. However, SMS cannot send and receive long text messages like FAX. Its use is limited as a means of transmission for supplementary purposes.

(4) Internet E-Mail

E-mail is also used alternatively if local agencies do not have FAX or if the message is lengthy and SMS cannot be used as a proper tool of transmission.

(5) PAGASA Internet Web

This is another means of communications for redundancy to deliver flood information to the Sub-Center and the concerned agencies as well as to disseminate the same information to local residents. The flood information is uploaded every day on the PAGASA website. However, local internet access is sometimes impeded due to a convergence of traffic and the problem of land lines for access.

(6) Media and Press

Media and press are effective means of disseminating information to the public. PAGASA/HMD releases flood information to the tri-media so that the public can be prepared earlier for an imminent disaster and can evacuate with sufficient lead time. Media and press crew are routinely stationed at PAGASA and are on standby for weather press releases.

The tables for available conditions of communication methods are attached in the List of Tables. Refer to Tables 9.3.1 to 9.3.4 for respective site-wise information on the available conditions of communication methods.

9.3.4 Crucial Issues

(1) Regarding the transmission and dissemination of monitored data for the river basins in Agno and Pampanga, PAGASA/HMD currently follows the rules and procedures stated in the manuals: The Dam Discharge Manual and The Operation Manual of Flood Forecasting and Warning System for River Basin, revised and updated in 2012. The methodology stated in the manuals should be developed for the other river basins as well. In order to accomplish this objective, the following issues in connection with the data transmission should be discussed.

(2) Real-time hydrological data for Bicol and Cagayan river basins currently cannot be monitored at PAGASA/HMD due to interference from cellular mobile phones which share the same frequency. The VOIP FAX/TEL or dedicated communication line is currently not available so public telephone lines such as PLDT, Bayantel, Digitel, etc. are being used. The issue of a dedicated communications network should be discussed.

(3) Regarding the New River Basins without FFWS, a dedicated line should be considered for future development of transmission and dissemination of data because the public line telephone sometimes cannot be used due to landline problems and convergence of much traffic. There are several methods of transmission now available such as satellite communications, microwave radio links, and IP-VPN leased from telecommunication carries. In view of cost and performance, the most appropriate solution should be further discussed.

9.4 Communications Systems

9.4.1 Current Status

For the transfer of the flood information and warnings, OCD-NDRRMC currently does not have its own dedicated communication network unlike PAGASA/HMD which has a dedicated communications network for FFWS. The current communications system is composed of Internet E-Mail, FAX/TEL, Short Message Service (SMS) by cellular phones, VHF radio for short-distance communications, and INMARSAT portable satellite phone equipment. The network configuration is shown in the next page.

(1) Internet E-Mail

E-Mail, Website and Social media like Twitter services provided by Internet Providers are used to send flood information and warnings from OCD-NDRRMC to RDRRMC, PDRRMC, and MDRRMC simultaneously.

(2) SMS Multi-cast

There are SMS gateways installed at OCD-NDRRMC and RDRRMC. The SMS gateway can distribute short messages to the addresses registered beforehand. The SMS gateway at OCD-NDRRMC delivers messages to RDRRMC member agencies and TV media while the SMS gateway at RDRRMC sends out messages to PDRRMC and MDRRMC.

(3) FAX/TEL

There are four sets of FAX/TEL machines installed at OCD-NDRRMC for transmittal of flood information to 17 RDRRMCs nationwide. After sending through FAX to the other end, receipt is immediately confirmed using a telephone.

PAGASA/HMD also uses FAX/TEL to release their flood information and warnings to OCD-NDRRMC at the same time, they send the same information through their dedicated communications network.

(4) VHF Radio

There are two VHF transceivers installed at OCD as a means of short-range communications. One is used for communications among government agencies such as NDRRMC, MMDA, OCD-NCR, Armed Forces, Bureau of Fire Department, and other concerned government agencies. The other, donated by KOICA, is exclusively used for communications between PAGASA/HMD and OCD-NDRRMC.

(5) INMARSAT Portable Satellite Phone Equipment

There are a total of ten sets of INMARSAT Portable Satellite Phone Equipment donated by the European Commission. Two sets are kept at OCD-NDRRMC while the other eight sets are distributed to the regional centers as follows;

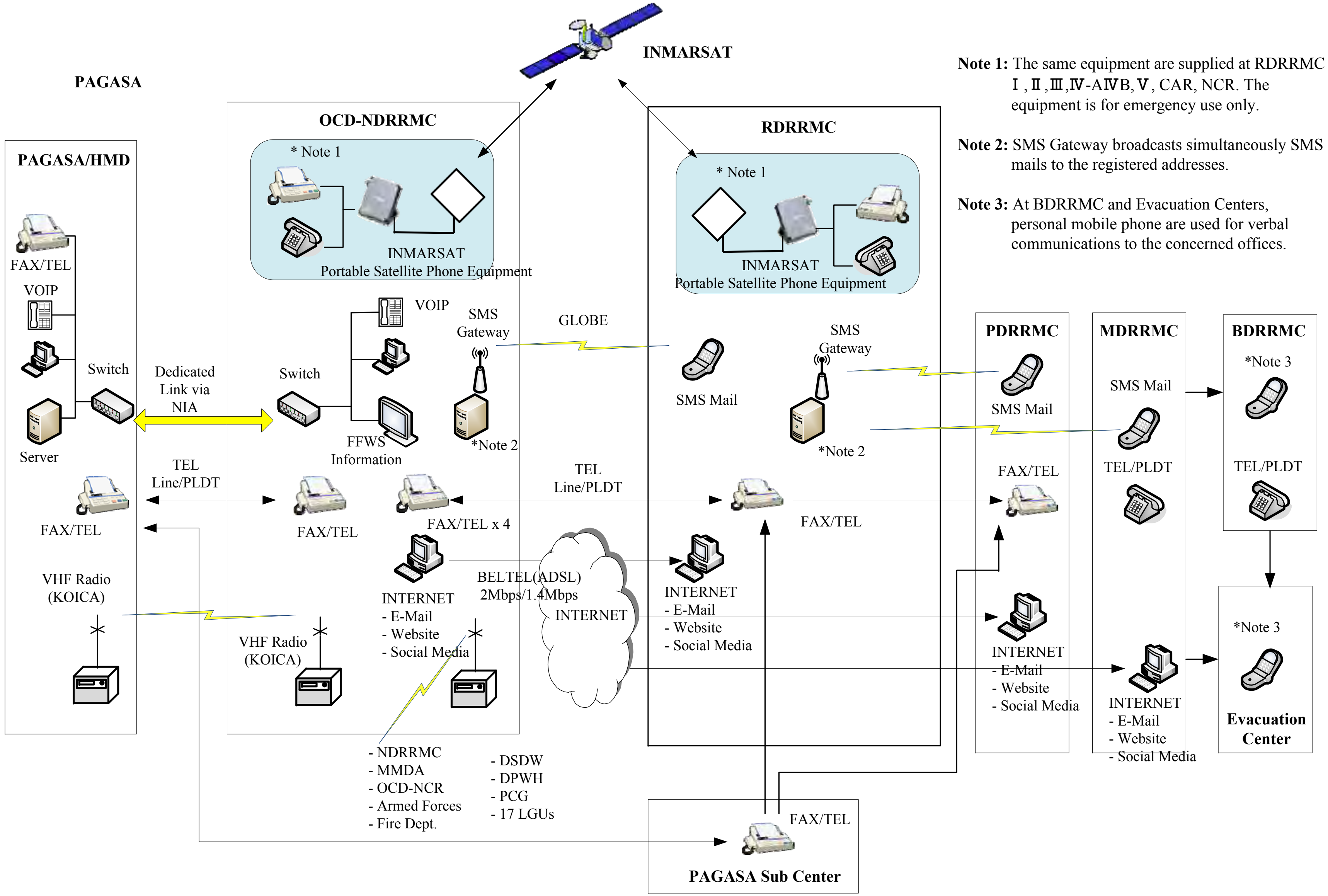
Regional Center I	La Union
Regional Center II	Tuguegarao Cagayan
Regional Center III	Pampanga
Regional Center IV-A	Calamba Laguna
Regional Center IV-B	Batangas
Regional Center V	Legazpi City
Cordillera Administration Region	Baguio City
National Capital Region	Quezon City

This equipment is exclusively limited to emergency communications and is not used for the usual transmissions of the flood information and warnings from OCD-NDRRMC.

(6) Dedicated Communications Network between PAGASA/HMD and OCD-NDRRMC

PAGASA/HMD and OCD-NDRRMC are connected by their dedicated circuits. PAGASA/HMD delivers real-time weather images to OCD-NDRRMC so that they can monitor it on a PC display installed at the OCD-NDRRMC office. VOIP and FAX are also available on their dedicated communications network.

(7) For communications at municipal and barangay levels, the municipalities in Metro Manila and its vicinities have FAX machines for communications with such related agencies as PAGASA, NIA, and NPC while the municipalities of remote regions and provinces do not have FAX machines, thus they cannot receive and keep the records of the flood warning information from PDRRMC. BDRRMCs are not provided with mobile phones for SMS text. They communicate with PDRRMC or MDRRMC using their personal cellular phones to collect flood information and warnings. They cannot access the Internet E-mail either.



Source: Study Team

Current Communication System for OCD and Related Offices

9.4.2 Crucial Issues of Current System

The communications system of OCD-NDRRMC and its subsequent offices have several issues that may prevent the quick dissemination of the flood warning and information down to the Barangay Captain. Thus, inaccurate transfer of messages may occur. The following issues and problems are pointed out:

(1) Inadequate Means of Communications Networks among municipal and barangay members in remote regions and provinces

Among community residents, communication is conducted verbally and no record of handling messages is kept due to insufficient means of communication equipment. This could result in confusion regarding information on warning levels and direction of their evacuation since accurate information may not reach them. Further, cellular phones possessed by MDRRMC and BDRRMC in remote regions and provinces and the Evacuation Center are personal units for both private and official use in time of disasters.

(2) Unreliable Communications at MDRRMC

According to interviews conducted by the Study Team, the OCD Operation Center staff mentioned that they do not have any emergency generator. For that reason their communication equipment is out of service during instances of power failure. Also, their Internet does not have a reliable connection especially when heavy rainfall and storms occur.

(3) Dedicated Communications Network between PAGASA/HMD and OCD-NDRRMC

The network is connected from the PAGASA Main Operation Center (MOC) to the Science Garden and extends to OCD-NDRRMC relayed via the NIA FFWS center. Currently, WiMAX is temporarily used between the Data Information Center and the Science Garden because the optic cable previously laid was damaged during road construction. PLDT optic fiber is now being used between NIA FFWS Center and OCD-NDRRMC because the line of sight had been blocked by construction of high-rise buildings. There is no duplicated circuit for redundant operation.

(4) Communications dependent on Telecom Carriers and Providers

OCD-NDRRMC has its communications network that adopts SMS multi-cast, Internet mail, FAX/TEL, and satellite phone. However, they all depend on public telephone networks of telecom carriers and providers. In fact, these networks implicate some connectivity risks when large scale disaster occurs. Due to too much convergence of traffic, telephone connections become difficult. FAX/TEL, Internet or SMS may not be used since people rush to telephones when such disasters happen.

(5) One way Communications

SMS multicast and Internet are basically one way communication in which information flows from OCD-NDRRMC down to BDRRMC in one-way direction. Two-way connectivity that can send and receive information simultaneously is necessary. Under the present circumstances, it is difficult for OCD-NDRRMC or R/P/MDRRMC to retrieve information from the site of disaster.

Should floods occur, real-time disaster situation at the site must be accurately grasped by OCD-NDRRMC or R/P/MDRRMC so immediate disaster relief countermeasures may be accordingly undertaken.[1]

The feasibility of Japanese communications technologies in the Philippines, like those mentioned in Section 10.6, should be discussed.

9.5 Currently Used Information Communication Technology (ICT)

9.5.1 Development of PAGASA ICT

PAGASA has long been dependant on conventional telecommunications systems such as HF/VHF/UHF radios, microwave multiplex, satellite and optic fiber for its collection of weather data. However, along with the recent advent of Information Communication Technology, PAGASA started moving towards the establishment of its own IP-based computer network systems, organizing the Task Force Team of ICT experts with the clear objective of catching up with the latest IP technology available in the market. This Team, called ICT Group, is newly organized through recruitment from several sections for computer network operation and maintenance and is made up of 11 staff with the talent and skills required, under the direct management of the PAGASA administrator.

9.5.2 Networking of PAGASA ICT

Weather services, such as weather forecasts and issuing typhoon warnings, are made possible through analysis of outputs of numerical weather prediction models (NWPs) based on accurate data collection. Such satellite and radar weather data and data of nationwide observatory stations (both automatic and synoptic stations) are transported to PAGASA Main Operation Center (PAGASA MOC) through the existing communication networks. Crucial for the implementation of its activities, PAGASA is currently improving its communication networks through PAGASA ICT as described above. The PAGASA MOC has been connected with four PRSDs, El Salvador in Mindanao, Tuguegarao in Northern Luzon, Legazpi in Southern Luzon and Mactan in the Visayas. The PRSDs are linked by both Commodity Internet and IP-VPN, provided by telecommunication carriers and ISP providers. It has now become possible for PRSD workstations to download and update weather data such as radar images, IHPC (Integrated High Performance Computing) output models and other products directly from the FTP server located in the PAGASA MOC.

[1] Interactive communications must be a basic requirement for disaster operations in Japan. The loudspeaker-post simultaneous communication systems, widely operational in Japan, have now been changed from analog to digital in order to provide the interactive communications.

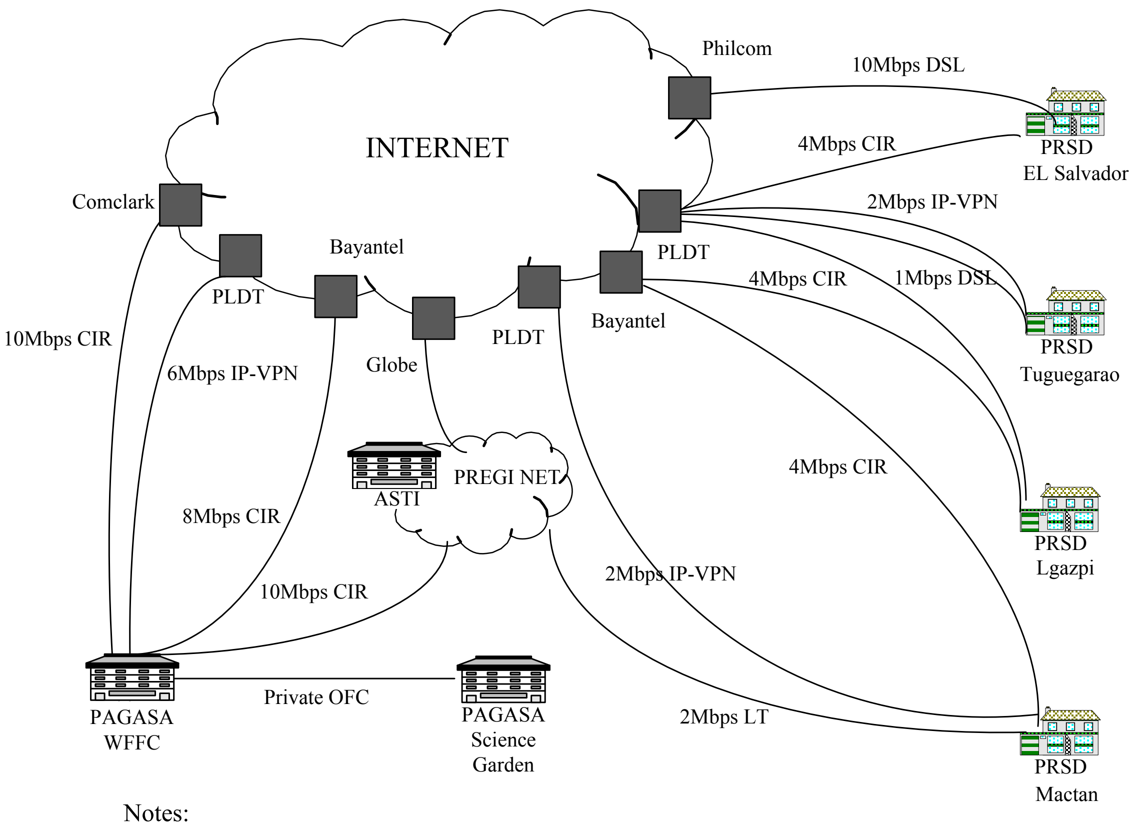
PAGASA has established the following systems using ICT:

PAGASA's ICT Systems

System Name (Division)	Purpose	Platform	Launched	Operation System	Developmen t tools	Information Sharing
CAAM Model Plan (CAP)	Climate prediction	Linux Web Server	January 2011	Linux	Linux, HTML	ASTI
NMG (IHPC)	Daily weather forecast	Web network	2012	Linux	Java, Linux	
PAGASA Web (TAMSS)	Daily weather forecast for all clients (aviation, farming, navy/ocean fisheries)	Web network	January 2011	Windows & Linux	PHP, Java	With Twitter and Facebook

Source: PAGASA

The PAGASA internet is composed of leased line service a.k.a. IP-VPN and Commodity Internet as shown in the figure below. The INTERNET access lines are configured in redundancy to improve network reliability.



Notes:

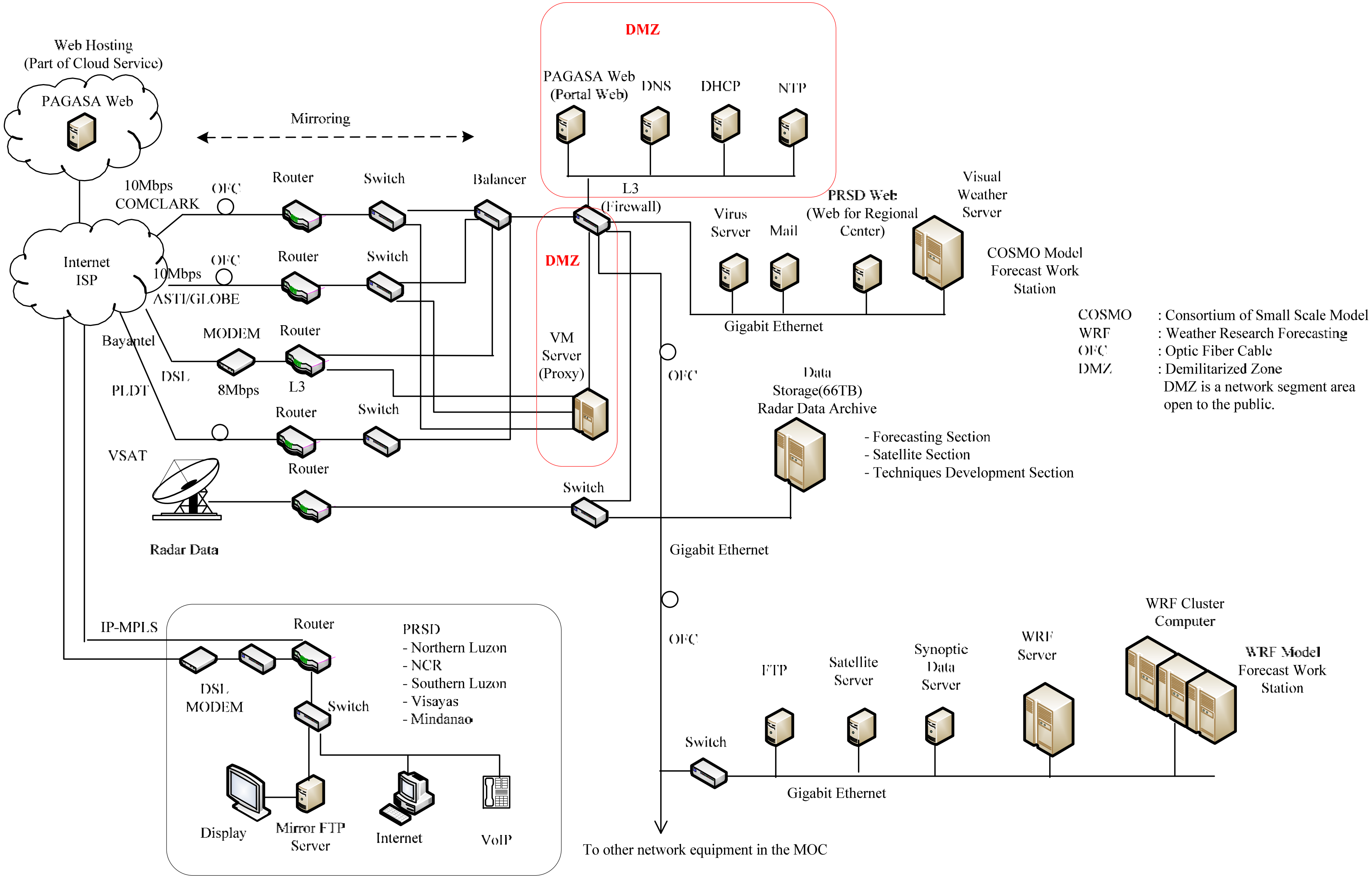
CIR	Committed Information Rate
PREGEI NET	Philippines Research Education Information Network
LT	Local Transport
DSL	Digital Subscriber Line
IP-VPN	Internet Protocol-Virtual Private Network
OFC	Optic Fiber Cable

Source: Study Team

Current PAGASA ICT Network

9.5.3 ICT Configuration of PAGASA Main Operation Center

The current ICT network of PAGASA MOC is shown in the following connection diagram. PAGASA has internet access through four internet service providers. PLDT provides IP-VPN service, which is highly secured and guaranteed like a leased line. The other three providers offer commodity internet access with CIR (Committed Information Rate), meaning that internet service quality is guaranteed by ISP. Physically, internet access lines to ISP are either metallic or optic fiber cables, and a Load Balancer is provided to connect through the routers and switches. This Load Balancer distributes IP packet data to different plural ISP lines both to help balance traffic and to realize redundancy at the same time. The L3 switch serves to route traffic and as a network firewall which configures the Demilitarized Zone. Servers indicated in the diagram, such as PAGASA Web, DNS, DHCP and NTP, are open to the public. Routers, switches and servers are connected by G-bits Ethernet. Regarding the power supply to the ICT network, AC power feeds it through the existing emergency generator supply and the network equipment is backed up by individual AC UPS in case of a possible commercial power failure.



Source: Study Team

PAGASA ICT in the Main Operation Center

9.5.4 Crucial Issues

The PAGASA ICT is still a fledging and the followings should be noted to ensure the integrity and reliability of the system.

(1) Skilled ICT engineers and technicians are urgently needed for a full implementation of PAGASA ICT's scope. Special priority should be given to the human resource capacity building of the Hydrological Telemetry Section HMTS. The ICT organization should be so structured as to cope with further advancement of PAGASA ICT.

(2) PAGASA should establish its own security policy to protect its own network system form external computer threats.

(3) Currently the PAGASA HMD network is a closed system and physically separated from the ICT network mentioned in the previous paragraphs. It is recommended that the HMD network be integrated into the ICT network in order to share the rainfall and water level data obtained in the local PRSD.

(4) The core network equipment, such as the Load Balancer and the Core Router/Switch, is not configured in redundant operation. The core network equipment should be duplicated in operation.

(5) The system should be properly protected from external computer attacks. PAGASA ICT does not have a Unified Threat Management System - such security devices as firewall, IDS, IPS which are now widely available in the market.

(6) The non-break power packages feed the network equipment individually and they are not consolidated as a power supply system. They should be designed to upgrade the power supply's system reliability.

CHAPTER 10 PRELIMINARY STUDY ON CANDIDATES OF JAPANESE TECHNOLOGIES

10.1 Basic Strategy for Adaptation of Technology in Japan

There is a rapid development of technologies using satellites in the telecommunication and telemetry industry worldwide. Both of them are affiliation and will greatly affect the future development of flood forecasting and warning systems in the Country.

The Government of Japan is now strengthening its effective utilization of meteorological information through satellites and the enhancement of numerical software. One of the movements is the development and application of IFAS, which is a flood runoff model using satellite rainfall data developed by ICHARM.

The matured technologies in Japan such as VHF/UHF radio telemetry, flood warning facility using a loud speaker and motor siren and digital multiplex radio etc, which have been developed for DRR works under MLIT (Ministry of Land, Infrastructure, Transport and Tourism) in Japan for long time, can be applied to the FFWS/FFWSDO.

In recent years DOST-PAGASA is proceeding to apply such advanced technologies into meteorological data acquisition/dissemination and rainfall forecasting, etc. that can be seen in the Project NOAH.

In this context, there are appropriate technologies which are developed and currently applied in Japan. Transferring technologies to the Philippines will improve the capability of monitoring and forecasting of rainfall in the future.

10.2 Candidate Japanese Technologies to be considered

In accordance with the basic concept as mentioned in the previous Section 7.1, the following technologies are preliminarily selected and assessed taking into account the possibility of transfer to the Philippines:

(1) Rainfall observation by radars
(2) Rainfall observation by satellites and discharge computation
(3) Terrestrial Digital TV
(4) Disaster information multi-delivery
(5) Matured technologies

10.3 Rainfall Observation by Radars

10.3.1 The Situation of Radars in the Philippines

PAGASA presently has nine operational Doppler radars and has plans to install five additional Doppler radars and to repair one Doppler radar. The current status of PAGASA radars is shown in the following table, and location of the radars is shown in the subsequent figure in next page. Most of the land of the Philippines will be monitored by radar observation network using 15 Doppler radars. Besides, PAGASA has a plan to procure mobile type of X-band MP radar.

Current Situation of PAGASA Radars

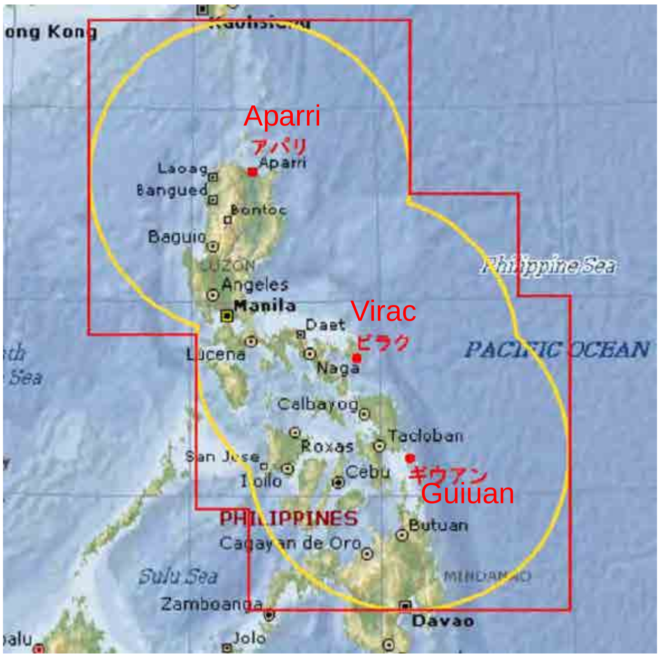
Name	Coordinates		Site Elevation (m)	Status	Fund
	Latitude	Longitude			
Aparri	18° 21' 35.48" N	121° 37' 49.10" E	4	Operational	JICA
Baguio	16° 21' 22.68" N	120° 33' 32.19" E	2,256	Non-operational (to be repaired)	GOP
Baler	15° 44' 56.70" N	121° 37' 56.60" E	176	Operational	GOP
Subic	14° 49' 19.43" N	120° 21' 49.27" E	452	Operational	GOP
Tagaytay	14° 08' 31.16" N	121° 01' 20.44" E	729	Operational	GOP
Virac	13° 37' 47.16" N	124° 20' 02.59" E	221	Operational	JICA
Mactan	10° 19' 21.37" N	123° 58' 49.15" E	26	Operational	GOP
Hinatuan	8° 22' 02.90" N	126° 20' 17.30" E	6	Operational	GOP
Tampakan	6° 24' 58.16" N	125° 01' 46.44" E	1,054	Operational	GOP
Guiuan	11° 02' 43.62" N	125° 45' 20.16" E	86	Installed in June 2013	JICA
Quezon, Palawan	9° 13' 50.01" N	118° 00' 20.01" E	13	Proposed	GOP
Busuanga, Palawan	12° 05' 22.10" N	119° 56' 15.12" E	215	Proposed	GOP
Jaro, IloIlo	10° 46' 20.00" N	122° 34' 45.08" E	2	Proposed	GOP
Zamboanga	6° 54' 00.00" N	122° 04' 00.00" E	6	Proposed	GOP
Basco, Batanes	20° 25' 14.87" N	121° 57' 54.76" E		Proposed	GOP
Mobile type X-band MP radar	Mobile type			Proposed	GOP

Source: PAGASA

Source: PAGASA

Location of PAGASA Radars

S-band Doppler radars in Aparri, Virac, and Guiuan have been installed by JICA. The observation capacity of the three Japanese radars is strengthened from 300 km to 450 km for sensitivity of more than 1 mm rainfall depth. Radar-echo composite maps will be provided with the three radars. The coverage area of the Japanese radars is shown as follows:



Source: JICA

Coverage Area of PAGASA Japanese Radars

The operational Doppler radars are to be calibrated to estimate accurate rainfall distribution. The observed data should be used considering its accuracy and limitation of observation capacity. PAGASA is presently conducting validation of radars as follows:

- Validation of Subic radar rainfall estimates for the Agno and Pampanga River basins
- Inter-comparison and validation of radar rainfall estimates using rain gauge data for the Hinatuan and Cebu radars

10.3.2 Characteristics of Radar Technologies

(1) Wavelength of Radar

Three types of wavelength are used for rainfall observation radar namely, S-band, C-band and X-band. The characteristics of each radar type are tabulated as follows:

Characteristics of Radars Considering Wavelength

	S-band	**C-band**	**X-band**
Wavelength	10 cm	5 cm	3 cm
Coverage area	More than 200 km	120 km	60 km
Sensitivity to rainfall	Weak	Medium	Strong
Wave damping due to heavy rainfall	Very small	Small	Large
Spatial resolution	Several km	1 km	250 m
Observation interval	-	5 minutes	1 minutes

Source: Study Team

S-band or C-band radars are used for typhoon observations due to its wide coverage area. On the other hand, X-band radars are used in small scale weather disturbance observations.

(2) Observation Parameter of Radar

Conventional rainfall radars estimate rainfall using radar reflectivity factor (Z). The equation for rainfall estimation is described as follows:

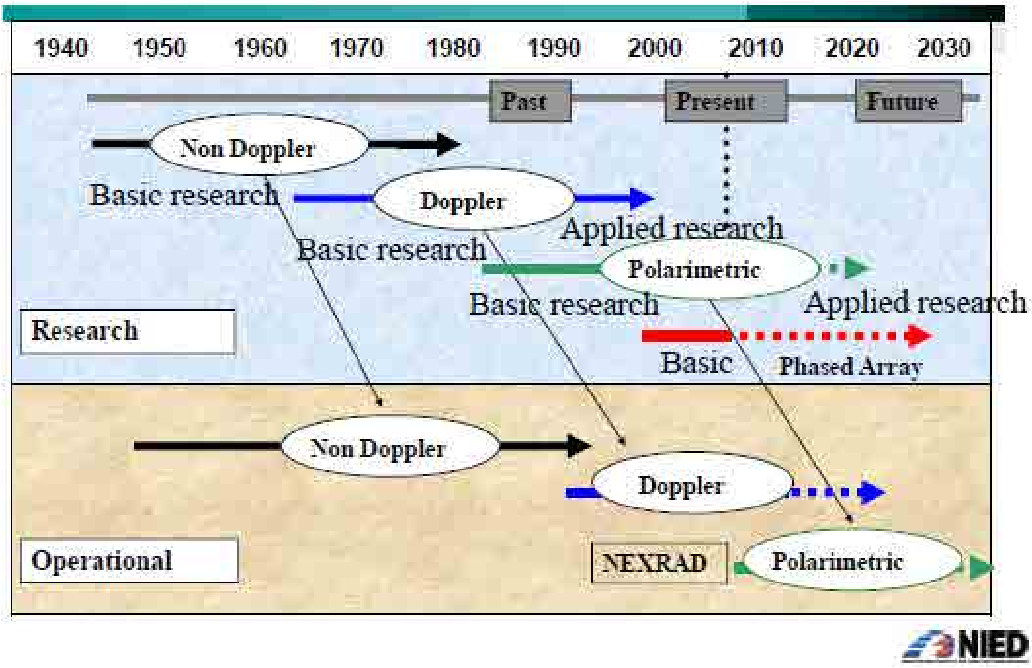
$$\mathbf{Z = Br^{\beta}}$$

where, Z: radar reflectivity factor
r: rainfall depth
B, β: constant

There are several problems in rainfall estimation using conventional rainfall radars. Examples of these problems include different B and β for various types of weather disturbances, and wave damping due to heavy rainfall.

The current operational Doppler radars can observe wind speed and direction by Doppler effects in addition to rainfall depth by radar reflectivity factor. Wind speed and direction data are effective for typhoon observation.

Recently, rainfall estimation using specific differential phase (K_{DP}) of dual-polarization radar has been developed, and is now practically used as X-band MP radars. The C-band dual-polarization radar however is still under research phase. The accuracy of rainfall depth estimation was greatly improved after using K_{DP} instead of using Z. The history of weather radar development in Japan is shown as below:

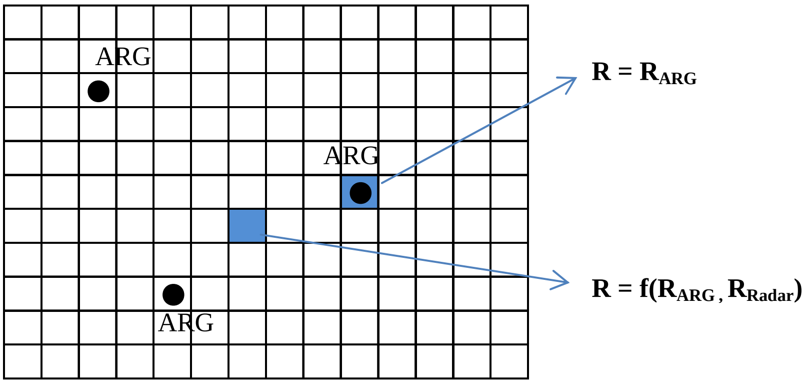


Source: http://hmd.dpri.kyoto-u.ac.jp/nakakita/kikou090226.pdf

History of Weather Radar Development in Japan

(3) Correction of Radar Rainfall Estimation Using Automated Rain Gauges

The rainfall estimation capacity of radars has been improving every year. In addition, correction methods of radar observation are also being developed. The estimated rainfall distribution by radars can be corrected with in-situ data of automated rain gauge network as shown as below:



Source: Study Team

Schematic View of Corrected Rainfall Estimation

10.3.3 Applicability of Radar Technologies in the Philippines

(1) X-band MP Radar

The rainfall observation characteristics of X-band MP radars are listed below:

- Accurate observation of rainfall depth
- Smaller coverage area of observation compared with the other types of radars
- Blind observation area in heavy rainfall events due to wave damping

In case of Japan, several X-band MP radars are located in urban areas to observe small scale weather disturbances such as thunder storms. The layout of X-band MP radars is dense, and the coverage area of each radar overlaps with others considering blind observation area in heavy rainfall events.

In case of PAGASA, X-band MP radar will be procured and be operated for research purposes. It will take time for X-band MP radars to be in its operational phase. Besides, there is a concern regarding wave damping due to the large size of raindrops in the Philippines. This will be effective and efficient that the Flood Forecasting and Warnings Division (PAGASA HMD) use operational C-band or S-band Doppler radars to the greatest extent possible, rather than X-band MP radar.

(2) Correction of Radar Rainfall Estimation Using Automated Rain Gauges

To improve the monitoring capacity of typhoons, estimated rainfall by operational C-band or S-band Doppler radars can be corrected using ARGs, and can be used as input data for flood runoff models. In case of Japan, the correction approaches started from 1983 with the combination of JMA radars and JMA Automated Meteorological Data Acquisition System (AMeDAS). It presently operates the correction approaches by using all of available radars and ARGs among related agencies. These correction approaches can be applicable in the Philippines also.

10.4 Rainfall Observation by Satellites and Discharge Computation

10.4.1 History of IFAS

The International Centre for Water Hazard and Risk Management (ICHARM) was established under the proposal of the Japanese government to UNESCO and the United Nations, in response to the increasing severity of water related hazards worldwide. One of the main projects of ICHARM is the development of its Integrated Flood Analysis System (IFAS). The system was developed to help countries with insufficient river improvements, where smooth evacuation during floods is important for reducing loss of life and property.

IFAS implements interfaces to input not only ground-based but satellite-based rainfall data, GIS functions to construct flood runoff models, a default run-off analysis model, and interfaces to display output results. This satellite based rainfall data and GIS estimated parameters can be reliably used to conduct flood runoff analysis in cases with insufficient hydrological and geophysical data.[1]

10.4.2 Present Situation of IFAS and GSMaP in the Philippines

In the Philippines, IFAS has been initially applied in the Pampanga and Cagayan river basins through the conduct of workshops and seminars by ADB funds. Experts from ICHARM presented their analyses on both river basins. Local PAGASA staffs also performed hands-on training and minor simulations of IFAS runoff models. The IFAS seminar was completed in October 2012.

At the same time, trainings on PAGASA staff to use IFAS were conducted in Japan by JICA. They gained capacity to develop IFAS models with some assistance from ICHARM.

On the other hand, JAXA developed Global Satellite Mapping of Precipitation (GSMaP). GSMaP is rainfall estimation products by satellite remote sensing technologies, which is provided within four hours after observation. GSMaP was used as one of the input data for IFAS in ADB project.

10.4.3 Next Steps of ADB Project in the Cagayan River Basin

According to one of the PAGASA senior staff that the Study Team has interviewed, it was identified that the results of the IFAS workshops showed much potential in the use of the IFAS software for river basins with different characteristics. However, further fine tuning and calibration of parameters is required to get accurate outputs. Also, one of the problems of PAGASA is converting old rainfall data which are in Excel format to IFAS format.

In order to fully utilize the IFAS system in the future, additional rain gauge stations may be installed in the Cagayan River basin which currently has poor ARG density (when compared with the high ARG density of the Pampanga River basin). Aside from the two mentioned river basins, the IFAS system may also be expanded to other major river basins as well. The conversion of old rainfall data to IFAS data should also be considered.

[1] Source: Development of Integrated Flood Analysis System and its Applications; Tomonobu Sugiura, Kazuhiko Fukami, et. al., 7th ISE & 8th HIC, Chile, 2009.

10.4.4 Applicability of IFAS and GSMaP in the Philippines

One of advantages of GSMaP is that it can estimate rainfall where there is no available rainfall gauges. Disadvantages are that data is available only in four hours after observation, and accuracy of rainfall estimation is low. It is appropriate to apply GSMaP on basins where few rainfall gauges are available and of which basin areas are wide considering its advantages and disadvantages.

The basin area of the Mindanao River basin is approximately 23,000km^2, and it is the second largest basin in the Philippines. Besides, only few rainfall gauges are available in the basin. The upstream area of Agusan River basin is also similar situation as the Mindanao River. Therefore, application of IFAS and GSMaP in the Mindanao River basin and the Agusan River basin for flood forecasting and warnings will be effective.

10.5 Terrestrial Digital TV

10.5.1 Technological Features of ISDB-T

There are three prevailing types of terrestrial digital TV adopted worldwide.

(1) ATSC: Advanced Television System Committee, Developed in USA
(2) DVB-T: Digital Video Broadcasting – Terrestrial, developed in EU
(3) ISDB-T: Integrated Service Digital Broadcasting – Terrestrial, developed in Japan

Among those standards ISDB-T has been one of the most sophisticated digital broadcasting technologies developed in Japan. Since the start of Japanese ISDB-T service in December 2003, Japan completed the whole transition of broadcasting system in July 2011.

ISDB-T can broadcast simultaneously High Definition TV (HDTV) program as well as One Segmented OFDM Transmission program or so called "One-Seg" program which is the name of a type of broadcasting service for handheld receivers such as cellular phones. One-Seg portable reception service was started in April 2006.

The ISDB-T has a lot of flexibilities and possibilities as above and has rapidly migrated because of its advantages as described below. In other words, ISDB-T has a potential for the creation of new services for telecommunication carriers and broadcasters. One-Seg broadcast service is a very good example.

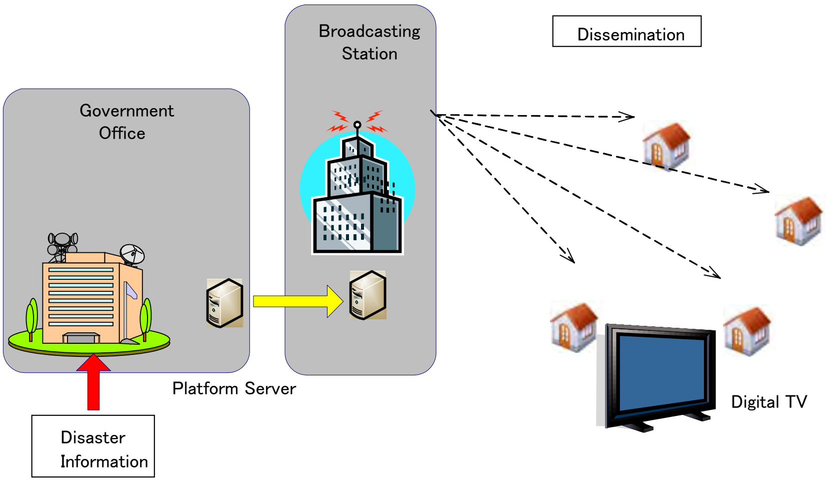
The features of ISDB-T are described as follows:

(1) High quality and Multi-Media

MPEG-2 and MPEG-AAC, high fidelity and efficient video/audio coding system are adopted multi-media broadcasting, digital technologies of ISDB-T such as data broadcasting, electronic program guide and interactive services of various kinds have been possible. By using this technology, it is possible to deliver weather forecast and flood information for early disaster relief and evacuation. The government offices issue such information through platform server system to the broadcasting stations that broadcast early warning information aside from normal programs. It is also possible to air such real-time and local information on water levels and rainfall of neighboring rivers to the local residents. The picture below shows a sample display of such data broadcasting.

Source: NHK

Sample Display of Data Broadcast about River Water Levels Information



Source: Study Team

Configuration of Disaster Information Transmission by using Digital TV

(2) Robustness to Multipath Fading

Transmission modulation technologies such as Orthogonal Frequency Division Multiplexing (OFDM) with time interleave make it possible to realize a robust reception against multi-path interference (static and dynamic), urban noise, fading of mobile/portable reception and others. While driving a car, it is possible to have a stable TV reception.

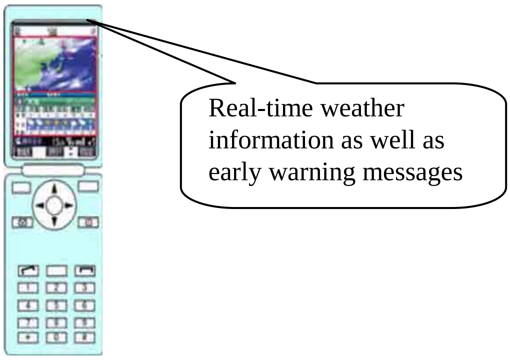
(3) Single Frequency Network (SFN)

By adopting OFDM technologies, it is possible to design Single Frequency Network enabling it to use the same frequency in one service area.

(4) Mobility/ Portability and Disaster Warning

ISDB-T has adopted unique technology of Segmented OFDM transmission system or One-Seg service. Segmented OFDM transmission system uses one segment (432 KHz) out of the total of 13 segments (6 MHz bandwidth) in one channel, so it does not require much power consumption and enabling a long time reception with the use of a battery.

Because of its mobility and portability “One-Seg” reception can be incorporated into cellular phones. Together with telephone operators like Nippon Telegraph and Telephone Company and NHK (Japan Broadcasting Corporation) have been developing Early Warning System by using “One-Seg” broadcasting Service.



Source: Digital Broadcasting Experts Groups (DiBEG)

Sample Display of One-Seg Service

10.5.2 Possibility of Introduction of Early Warning by Using Digital TV

The digital TV technology has an extensive variety of applications not only for disaster prevention but also for interactive use through internet connection. Especially in view of disaster prevention it is no doubt beneficial to the Philippine people because they will be able to access the early warnings faster.

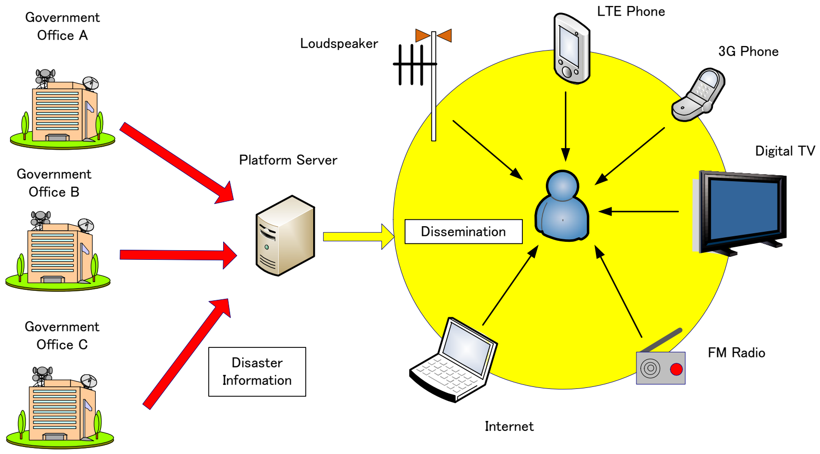
On June 11, 2010, the National Telecommunications Commission announced by its Memorandum Circular MC 02-06-2010, “Standard for Digital Terrestrial Television (DTT) Broadcast Service”, that the Philippine government will adopt and introduce Japanese Standard of Digital TV, namely ISDB-T, as their selection of digital TV System. But on March 27, 2011, the local regulator ordered an evaluation of the standard to be used by the Philippines for digital television and is reconsidering the second generation Digital Video Broadcasting from Europe. Currently the standards are still being reviewed.

The Philippine government also announced that it will complete the transition from analog to digital by the year 2015, however, it will be delayed due to undecided standard to be used and also it is likely to take several years more to accomplish its whole transition as indicated by the case of the same transition executed in Japan. Once they have completed the transition, it should be discussed further on the integration of featured functions of the digital TV into the early warning system in the Philippines too.

10.6 Disaster Information Multi-Delivery

10.6.1 Integration of Various Communication Systems

Since there are several means of dissemination to the local people, it is required to integrate those communication systems into one centralized information delivery system. The picture shows a conceptual model of this delivery system.



Source: Study Team

Conceptual Picture of Centralized Dissemination System

Disaster information dispatched from the government offices can be integrated into platform server and processed to appropriate outputs to deliver information to versatile means of communications. Local people can receive disaster information and emergency warnings from multiple sources, thus enabling them to evacuate quickly and safely with a sufficient lead time. The platform server will be a cloud system so that it can be more resistant and not affected by disasters.

10.6.2 A Variety of Communication Systems

There are a variety of dissemination methods available to local people when disaster happens. Some communication systems use loudspeaker warning posts through 60MHz digital radio while others use systems in collaboration with existing local broadcasts like FM radio, digital TV or public cellular phone system. The features of these communication systems of disaster information dissemination are briefly described as follows.

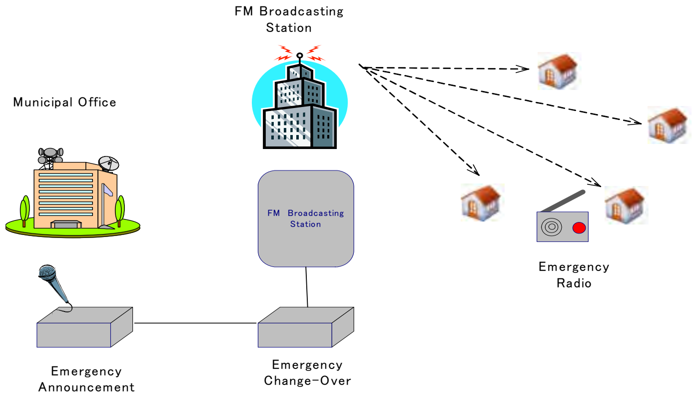
(1) Loudspeakers Broadcasting through 60MHz Digital Radio

This system has been widely adopted and installed in the municipal organizations in Japan. The local office can deliver daily announcements to its residents. Once a disaster happens, they can broadcast simultaneously emergency warning so evacuation can be done quickly. Optionally, picture viewing and signage (Letter Display) are available so they can monitor visually real-time scene of the disaster area and also provide a warning to sight-handicapped people.

This system is very useful though it is often difficult to hear announcements clearly at the time of heavy rain or when they stay inside their houses.

(2) Community FM Radio

Community FM radio is local broadcasting radio station of which the service area covers about 10 to 20km, roughly the same area size as local community area. It is often applied as an alternative means when you cannot hear loudspeaker at home indoor. The government office is supposed to have an agreement with the local community FM radio station for the emergency use of their radio station. When disaster happens, normal radio program interrupts and the local government can switch to emergency broadcasting to local people. The emergency radio receiver can automatically switch on to receiving mode.



Source: Study Team

Configuration of Community FM System

(3) Digital TV

As mentioned in the previous paragraph, the feature functions of digital TV are very much useful to deliver various types of information to local people. It can deliver weather information, typhoon, river inundation, water levels, landslide, etc.

(4) LTE and 3G Cellular Phones

When disaster happens, an emergency message will be delivered automatically to local people through cellular phones. (The emergency message is like SMS used in the Philippines.) The government office will issue an emergency message to the cellular phone operators who will proceed with the dispatch of an emergency mail to their users' phones.

(5) Internet

Internet is widely used as a means of collection of information. When disaster happens, the government offices, related agencies, and organizations upload the latest disaster information on their websites. People can collect the accurate information as they need.

10.6.3 Possibility of Adaptation in the Philippines

Even with sufficient reliability, the Cloud Computing System has not been fully developed and penetrated in the Philippines as yet. Therefore it should be necessary to study further on the telecommunication infrastructures and evaluate the reliability of the Cloud Computing System in the Philippines. However the concept of dissemination as described in the previous paragraphs should be useful and discussed for the disaster warning system in the Philippines. Dissemination is not fully secured if you have only one means of communication. You should have versatile means of dissemination like an emergency mail from cellular phone, evacuation announcement from radio, or TV or information on disaster prevention form internet websites.

10.7 Matured Technologies

The matured technologies developed by MLIT for FFWS/FFWSDO have been used in many river basins and dam sites, and have shown good performance. The technologies as mentioned below can be applied to the PAGASA's system enhancing the existing system. In addition, standard specifications of the equipment and guidelines can be applied to strengthen capability of PAGASA.

10.7.1 VHF/UHF Radio Telemetry

The VHF/UHF radio technology can be applied to data transmission in mountainous area due to feature of VHF/UHF radio wave which can override mountain to some extent, and IP technology is added to the VHF/UHF radio in recent year. This can be applied to the data transmission system from the rainfall/water level gauging stations to the new/existing river centers.

10.7.2 Loud-speaker and Motor Siren

Combination of loud-speaker and motor siren is effective facility to disseminate the flood warning to residents. Study and development to transmit more long distance and clear sound have been conducted in 2012 based on lessons learned from 2011 Great Ease Earthquake in Japan. The facility can be applied to the facility of FFWSDO and new flood warning system at downstream after the FFWSDO.

10.7.3 Digital 5.8-38 GHz Multiplex Radio and RPR

The digital Multiplex Radio equipment has been developed for usage of backbone network of communication system like the telephone system. Due to the development of the equipment technology and low cost, redundant communication system (1+1) is common way, and RPR (Resilient Packet Ring) equipment can be connected with the digital microwave network and optic fiber communication (OFC) network through loop configuration, which achieve redundant communication network. The combination of digital multiplex radio network and OFC network through RPR can be applied to PAGASA's backbone network.

10.7.4 WDM (Wavelength Division Multiplex) Technology

WDM technology can increase capacity of the optic fiber transmission from 2.4 Gbps to 10 Gbps and it has used in carrier company in worldwide. This advanced technology in Japan can be applied to increase the required data in PAGASA network in the future and coexistence of NGCP telecommunication system.

10.7.5 Technical Standard of Telemeter Equipments

Technical standard of telemeter equipments should be prepared in the Philippines. The following Japanese standards can be good example. However, the contents of the standards should be carefully studied considering the applicability to the Philippines, and related international standards should be also considered.

- Standard specification of telemeter equipments

- Standard specification of direct-current power supply
- Standard specification of microwave telemeter equipment
- Design guide of telecommunication equipment
- Guide of inspection on telecommunication equipment

10.8 Integration of Flood Forecasting and Warning Systems

(1) History

MLIT established its first FFWS in 1954, and keep operation with necessary maintenance, rehabilitations, and renewal of systems. The development stage of FFWS of MLIT can be described as five stages:

Stage 1: first telemeter system in 1954
Stage 2: river information system in 1975
Stage 3: new river information system in 1987
Stage 4: integrated river information system in 1996
Stage 5: unified river information system at present

(2) Integrated river information system in 1996

The system was designed to monitor the 109 river basins under the responsibility of MLIT. The design concept was to guarantee the connectivity of systems under multi-vendor environment. As a result, the standardization, which allowed connecting low spec systems and narrow communication links, was "standard for telemeter transmission of monitored data".

(3) Unified river information system at present

The system was designed to integrate in-situ monitoring data (rainfall and water level) and ground radar data, and to share the monitoring data with related agencies, such as the meteorological agency and the road construction and management agency. Therefore, Extensible Markup Language (XML) was introduced, which is universal format with high expandability.

Heretofore, Binary format makes data size small. However, data and documents for explanation of data should be prepared. All of system integration or modification works should be conducted by engineers who understand the documents. On the other hand, data itself and definitions of data can be embedded into XML data. Therefore, system integration or modification works can be easier than Binary format. Though, the data size of XML is larger than Binary, and load to systems and networks is heavier.

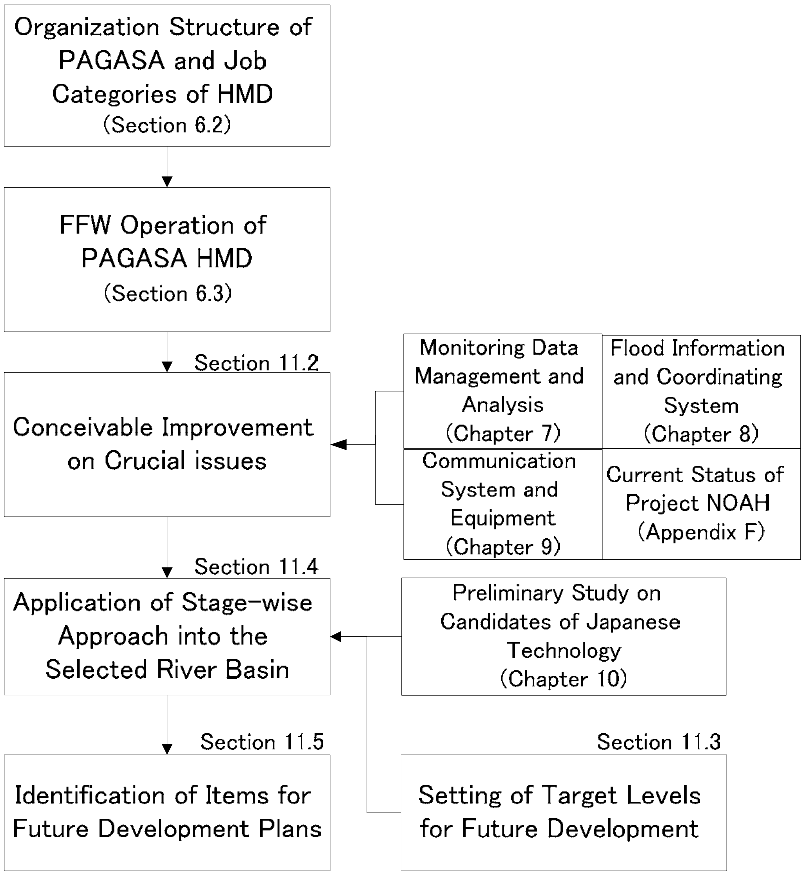
(4) Application to PAGASA system

PAGASA HMD operated PABC FFWS/FFWSDO system for these decades, and recently received additional systems, such as EFCOS and KOICA-II. There are needs for integration of systems. The experiences of system integration with multi-vendor environment in Japan will be good example for PAGASA.

CHAPTER 11 PRELIMINARY STUDY ON STAGE-WISE DEVELOPMENT IN TARGET RIVER BASINS

11.1 Methodology

Data from the various Chapters and Sections and their interrelationships established were verified. This linkage then served as the base for the identification of crucial issues for future development of FFWS/ FFWSDO. Subsequently, from the process of exploring solutions or improving the issues identified, a preliminary study on planning projects with corresponding relevant components was discussed in this Chapter. The flow of relationships among Chapters and Sections are shown as follows:



Source: Study Team

Workflow and Linkage of Descriptions in Corresponded Chapters and Sections

11.2 Conceivable Improvement on Crucial Issues

In order to respond to the needs of solving crucial issues, crucial issues were identified through the study as discussed in the previous Chapters. Some improvements to deal with both non-telemetered but also telemetered river basins were found in technical issues as follows:

(1) Monitoring

Location and number (density) of rainfall and water level gauging stations shall be examined and appropriately planned. Therefore, throughout the planning of monitoring network and target accuracy, evaluation of existing gauging stations will become necessary with consideration of classification of gauging stations. Increase of number of gauging stations without such strategy will cause deterioration of data quality and complicated operation and maintenance especially in the new river basins in the future.

(2) Data management

Contents of required flood information with accuracy and methodology of sharing and dissemination among the agencies concerned shall be considered. Centralization and accumulation of monitoring data at PAGASA WFFC from individual river basins (especially for river basins in Mindanao) shall be carefully planned with appropriate strategy of data quality control, automated data arrangement/sharing with the concerned agencies and realistic time frame for stage-wise grade up and renovation.

(3) Survey works

Topographic data of river channel and flood plain is a part of fundamental information for FFWS activities. However, first of all, only the cross section at water level gauging station(s) will be required for setting flood warning water levels to issue appropriate message for evacuation by local people. A comprehensive topographic survey then can be considered. In order to convert water level to discharge H~Q curves is necessary at water level gauging station(s). Periodical update of the curves will be important based on the discharge measurements and post-flood survey. As for further enhancement of data availability, applicability of remote sensing, LIDAR information and ADCP for discharge measurement shall be also considered.

(4) Flood runoff model

Based on the runoff characteristics and flood mechanism of respective river basins, appropriate numerical model shall be selected. However, at initial stage for installation of the system, flood forecasting by simple water stage-correlation method will be practical in particular for new river basins. Further, the priority areas targeted to issue the flood forecasts shall be examined at the first stage of system planning. Development of flood runoff model can be followed after accumulation of data at certain level. Flood runoff model is just a tool of FFWS.

(5) Inundation analysis model

In accordance with the PAGASA's mandate, forecast or nowcast of inundation information should be disseminated to the LGUs concerned. However, accumulation of required hydrological data such as river cross sections, DEM and flood monitoring records (flood hydrographs) will be prioritized before preparation of inundation analysis model in the respective river basins. Further, effective utilization and updating of available model developed by on-going projects will be important in collaboration with other agencies.

Conceivable improvement on crucial issues for future development of FFWS is summarized as follows:

Conceivable Improvement on Crucial Issues

Category		Conceivable Improvement on Crucial Issues for Future Development
Non-telemetered River Basins (survey, plan, design, and installation stage)		
1	Field investigation	-Field training of discharge measurement and data processing for the establishment of H~Q curves through the use of ADCP -Training for topographic and cross section survey including methodology of leveling of "Zero" gauge height at water level gauging stations -Training for propagation test of electronic wave for selection of data transmission line/network
2	Hydrological analysis	-Training of IFAS modeling and operation -Training for probability analysis of hydrological records -Training for creation of flood runoff model and inundation analysis -Training of hydraulic analysis (1D-model) by non-uniform flow in consideration of tidal effects -Training of remote sensing technology for rainfall observation and estimate -Training for LIDAR data processing and applied methodologies
3	System planning (meteohydrological aspect)	-Training for preliminary planning of hydrological monitoring network (water level correlation method) -Training of methodology for setting/updating of flood warning water levels at WL gauging station
4	System planning (data sharing/telecommunication aspect)	-Training for data transferring system with current technology of ICT -Preparation of operation manual of NOAH's gauging stations -Development of standard specification of telecommunication devices for FFWS -Development of data transferring method from the river basins in Mindanao
5	Basic design including preliminary cost estimate	-Training in selection of appropriate type of water level gauge and basic design of structure of gauge hut -Training for AutoCAD operation for design works
6	Equipment component	-Rain gauges, water level sensors, data storage and transferring system, PC/monitor and printing devices and telecommunication facilities, etc. to configure telemetry system connecting between G/S and the River Center
7	Overall aspect	-Methodology for overall planning of FFWS aiming at grade up in new river basins

Existing Telemetered River Basins (operation and maintenance stage)		
1	Monitoring and data management	- Reconfiguration of existing system with integration of different monitoring networks
		-Training for remote sensing technology
		-Updating/upgrading of existing database system
		-Training for utilization of Radar data for FFWS
2	Flood forecasting tools and coordination system	-Expansion and/or new development of flood runoff model and inundation model
		-Review/update of flood warning water levels at base points
		-Review and updating of H~Q curves
		-Review of flood warning water levels and contents of flood information
		-Review of data sharing and transferring method with applied ICT
3	Communication system and equipment management	-Increase of monitoring stations as well as classification of existing stations (1st and 2nd class)
		-Upgrade of NOAH and other stations to be effectively utilized for FFWS activities
		-Re-establishment of communication network for flood operation with renovation of telecommunication devices
		-Support for establishment of coordination system between PAGASA and LGUs in accordance with DRRM Act

Source: Study Team

11.3 Setting of Target Levels for Future Development of FFWS/ FFWSDO

11.3.1 Expansion of FFWS in Non-Telemetered River Basins

PAGASA, DPWH, and MMDA developed FFWS mainly through Japanese assistance in five major river basins, namely: Pampanga, Agno, Bicol, Cagayan and Pasig-Marikina River basins. Most of the existing FFWS except for the Bicol River basin are related to dam operation or flood control structures, including dams that are to be constructed. The remaining 13 out of the 18 major river basins as well as small ones such as the Mandulog River basin have no planned or existing dams or flood control structures. FFWS with a dam scheme have different components in flood forecasting and warning as compared to FFWS without a dam scheme. An effective and efficient scheme for FFWS without dams should be figured out. Planning and design of FFWS with telemetered and even non-telemetered river basins is the first challenge for PAGASA HMD. Considering such a situation, the FFWS used for small rivers in Japan can serve as a target prototype.

11.3.2 FFWS for Small Rivers in Japan

Small rivers in Japan are mostly handled by river management divisions of prefectures, which are similar to provinces in the Philippines. Automated water level gauges are set in rivers by the corresponding divisions. The observed data is automatically sent through telemeter system. The river management divisions then forward the observed data and flood warnings to municipalities, which are responsible for the evacuation of citizens.

The menus of FFWS for small rivers managed by prefectures in Japan are shown below:

Menus for FFWS in Stage-wise Development in Japan

Category	Minimum Level	Upgraded Target
Basic concept	- Setting target areas of FFWS - Setting control point for water level monitoring	- Improvement in accuracy of flood information for securing longer lead time
Equipments	- Automatic water level gauge at control point - Telemeter system between gauges and river management agencies - Communication system between river management agencies and municipalities	- Additional automatic water level and rain gauges
Hydrological Forecasting	- No forecasting	- Forecasting (water level correlation or flood runoff model)
Utilization of Historical Data for Flood Warnings	- Uses only channel flow capacity at first stage - Flood frequency considered to avoid frequent warnings after the accumulation of data	
Channel Flow Capacity	- At water level gauging station	- Up/downstream portions are considered.
Evacuation Lead Time	- Not considered	- Considered

Minimum Level before 2005 In Japan

Minimum Level after 2005 In Japan

Source: Study Team

The minimum level of FFWS for small rivers in Japan was changed in 2005 due to a revision of the flood fighting law. In the revised law, the consideration of channel flow capacity in the upstream or downstream portion and the consideration of evacuation lead time were added.

Flood warnings are also issued by the Japan Meteorological Agency (JMA) based on rainfall observation. These warnings are similar to the General Flood Advisories issued by PAGASA and cover wider areas than Basin Flood Bulletins. The resolution for JMA warnings was upgraded from the prefecture level to the municipality level in 2010.

FFWS in JMA, Japan

Type	Flood warning based on observed rainfall	
	Before 2010	**After 2010**
Resolution	Prefecture level	Municipality level

Source: JMA

11.3.3 Lessons Learned from FFWS for Small Rivers in Japan

The local governments of Japan manage several hundreds of rivers with only limited budget and limited number of staff. The menus of FFWS for small rivers in Japan are a good example for setting a minimum FFWS without dam scheme in the Philippines. During the discussion between PAGASA and the Study Team, PAGASA recognized the necessity for setting a technical standard and the advantages for the stage-wise development of FFWS particularly for new target river basins.

11.3.4 Setting Target Levels of FFWS in the Philippines

The review of the history of development in Japan and a series of discussions with PAGASA and JICA Philippine Office were conducted. As a result, the target levels for stage-wise renovation of FFWS considering firm progress of grade-up at each stage was examined for succeeding case study of the target river basins. The following three levels were set up:

Concept of Stage-wise Development of FFWS

Level 1	Level 2	Level 3
Conceivable Component		
Construction of river centers	Establishment of telemetering system between gauging stations and river center	Further enhancement of function of river center for FFWS
Topographic survey at water level gauging station	River cross section and longitudinal profile survey, discharge measurement	Application of LIDAR and ADCP technologies
Installation of one rain gauge & one water level gauge	Increase of gauging stations (rainfall & water level)	Further increase of gauging stations (rainfall & water level)
Setting of warning levels (WL & rainfall)	Forecasting by water level correlations of gauging stations	Preparation of flood runoff model & inundation analysis model
Securing communication link with LGUs concerned	Establishment of data transferring system from river centers to PAGASA WFFC	CCTV and other remote flood watching system by ICT technologies
YR1973 ~ 1986	**YR1987 ~ 2003**	**YR2004 ~ 2013 ~**
In case of Pampanga, Cagayan, Agno, Bicol	In case of Pampanga, Cagayan, Agno, Pasig-Marikina	Partially in Pampanga, Cagayan and Agno* (*: Flood runoff models cover the areas for dam discharge warning.)

Source: Study Team

<u>Level 1</u>: (1) Simple set-up of FFWS with minimum number of monitoring stations as well as communication link with LGUs should be considered.

(2) Simple warning standards of water level and rainfall at key gauging stations should be developed for dissemination of flood information to LGUs concerned.

(3) The River Center will function as the regional hub of FFWS.

<u>Level 2</u>: (1) Telemetry system to connect gauging stations and the River Center will be established.

(2) Flood forecasting by water correlation between u/s and d/s gauging stations will be started.

(3) Monitored records will be transferred from the River Center to PAGASA WFFC in Quezon City on real time basis.

Note: If PAGASA needs to realize the automated data transferring system from initial stage due to unavoidable external reason, possibility of installation of the system will be examined from Level 1 stage.

Level 3: (1) At this stage, it is presumed that monitored data might have been accumulated at a certain extent.

(2) Flood runoff model/ inundation analysis model will be developed to further elaborate flood information and warning in terms of accuracy and reliability.

Note: FFWSDO in the Magat/Cagayan, Agno and Pampanga River basins has reached this level subject to further improvement of monitoring network and data management, etc.

11.4 Application of Stage-wise Approach

11.4.1 Selection of River Basins for Identification of Development Needs

Among the target 19 river basins, the following 12 were selected and agreed upon with PAGASA during the preparation of the Interim Report in May 2013 as follows:

Selected river basins

Luzon : Cagayan, Agno, Pampanga, Pasig-Laguna de Bay, Bicol

Visayas : Jalaur

Mindanao : Agusan, Tagoloan, Cagayan de Oro, Davao, Tagum-Libuganon Mindanao (Cotabato), *Buayan.-Malungon*

Non-selected river basins :Abulog, Abra, Panay, Ilog-Hilabangan, Agus-Lake Lanao, Mandulog

However, in the course of follow-up study in August to September 2013, PAGASA requested to include the Buayan-Malungon River basin (General Santos is located), which was not selected previously, to add in the selected group above. In accordance with PAGASA management staff, the Buayan- Malungon is one of three river basins, which are first group of bidding procedure for construction of the River Centers (under the "River Center Project"). Other two river basins are the Tagum-Libuganon and Mindanao.

11.4.2 Non-telemetered River Basins

(1) Methodology

Considering identification of development needs in the river basins, where no telemetry system exists at present, the target level of FFWS (Level 1) was tentatively formulated as discussed in Clause 11.3.4.

On the other hand, the development procedure of FFWS can be delineated by ten steps as follows, based on the on-going Bicol Project:

1) **Data/information collection**
2) **Field investigation**
3) **Hydrological analysis**
4) **System planning (meteohydrological aspect)**
5) **System planning (data sharing/telecommunication aspect)**
6) **Basic design including preliminary cost estimate**

7) Detailed design (civil works and telecommunication works)
8) Preparation of bid documents/ drawings
9) Prequalification/bidding, evaluation and contracting
10) Construction and installation works

Note: The items in bold font refer to HMD's major present tasks.

Considering the present function and tasks of HMD, steps (1) to (6) in the items above will be covered by HMD. Therefore, the identification of development needs for the selected non-telemetered river basins was mainly focused these six steps up to the basic design stage as shown above.

The Agusan River basin in Mindanao, which is the 3rd biggest river basin in terms of the catchment area in the Country, was picked up for needs identification. It will be a high priority target river basin for earlier installation of FFWS to strengthen preparedness to flood disaster. This move is supported by the heavy devastation of the upstream basin by the latest flood of Typhoon Pablo in December 2012. Further, early warning system will be required in order to evacuate the people who are residing in riparian areas along the downstream stretches in Butuan City. Although the development plan of simple FFWS has been preliminarily studied during the Lower Agusan Development Project Phase II by DPWH in 2004 to 2005, it has not yet been realized.

(2) Identification of Development Needs (Agusan River Basin)

Assuming the Level 1 for the target, needs for future development was preliminarily identified. In particular, following needs will be essential for overall system design in case of the Agusan River basin from hydrological characteristics and target locations where seriously requires flood information:

1) River improvement with levee system (4 to 6 m high at both banks) at most downstream reaches of approximately 15 km from estuary has been implemented by DPWH (completion in 2005).
2) Bunawan Marsh is lying at middle reaches and functions as natural retarding basin resulting in retarding of flood peak discharge running into downstream reaches. Function of this marsh will need due attention from hydrological and environmental point of views.
3) The Compostela Valley located at most upstream area in the basin is susceptible to flash floods.
4) PAGASA has a plan to establish the river center at Prosperidad, Agusan del Sur under the "River Center Project".

The results of identification of development needs for the Agusan River basin are tabulated in Table 11.4.1 and summarized below:

Future Development Needs (Agusan River Basin)

Job Category		Future Development Needs
1	Data/information collection	-Topographic maps and river cross sections whatever available in the basin
2	Field investigation	-Training of respective elements of field survey and investigation
3	Hydrological analysis	-Application of IFAS for flood runoff analysis will be one option. -Overall training of applied hydrology with focus on FFWS
4	System planning (meteohydrological aspect)	-Training for preparation of flood runoff models and inundation analysis models
5	System planning (data sharing/telecommunication aspect)	-Training/practices of design works of telecommunication system and network
6	Basic design including preliminary cost estimate	-Training for design works for simple civil structures and telecommunication facilities

Source: Study Team

11.4.3 Telemetered River Basins

(1) Methodology

For the river basins with existing FFWS in the five river basins, operation and maintenance with enhancement of present system aiming at Level 3 for identification of development needs. Therefore, following procedure was applied in this Study:

1) To classify the job categories for FFWS works in PAGASA HMD during flood period as well as non-flood period based on the current routine in the Division
2) To identify the role demarcation among job categories in each section of HMD
3) To confirm current status including verification of achievement through recent donor’s projects and programs
4) To verify future development needs for elimination of gaps between the target Level 3 and current status

The identification of development needs of the telemetered river basins was conducted based on the records of interviews to the HMD staff and on the documents/output of the past projects/ programs collected through this Survey in March to August 2013.

Identification of development needs, which might be common in several river basins, was conducted in two river basins of the Cagayan and Pasig-Laguna de Bay. In the case of Cagayan, many activities are currently undertaken through the initiative and assistance of the Japanese side. In the case of Pasig-Laguna de Bay, the flood forecasting and warning activities are being conducted by PAGASA in coordination with MMDA based on the monitored record of EFCOS and KOICA from this rainy season. Therefore, it is judged that the development needs should be examined in this Study.

The results of identification of development needs are summarized below and tabulated in Table 11.4.2.

(2) Identification of Crucial Issues (Cagayan River Basin)

In the Cagayan River basin, the identification of crucial issues indicates the following key premises to be taken into consideration:

1) Former JICA TCP was conducted from October 2009 to November 2012 aimed at strengthening the FFWSDO for Magat Dam.
2) A total of 21 rain gauges and 10 water level gauges will be installed in the Magat River basin under NORAD in 2013.
3) ADB/JAXA and ADB/ICHARM conducted a regional technical cooperation program to apply space based technologies and information communication technology for improved river basin management in the Cagayan River basin.
4) IFAS training was conducted by ICHARM/JICA in 2012 (two staff of HMD participated in the training). A seminar for IFAS operation inviting LGUs was held in October 2012.
5) "The Study on the Nationwide Flood Risk Assessment Project and the Flood Mitigation Plan for the Selected Areas (March 2008)" is aiming at improvement in the downstream part of the Cagayan River. Its loan agreement was approved and exchanged between both Governments in 2012.

Items for Future Development (Cagayan River Basin)

Job Category		Future Development Needs
1	Basin/river system monitoring	・Effective use of synoptic and NOAH's monitoring stations (with development of management rules of monitoring stations)
2	Data collection for flood forecasting	・Utilization of rainfall data from the Doppler radar at Aparri should be enhanced and a Weather Forecaster shall be assigned at Tuguegarao Sub-center.
3	Database management	・Integration of database system ・Skill for updating of the database contents ・Data transferring system to concerned agencies
4	Discharge measurement	・Periodical review and update of H~Q Curves at WL stations
5	Assessment and update of flood warning water levels	・Review of the flood warning water levels in same manner at other key WL stations (recommended by former JICA TCP).
6	Flood forecasting	・Expansion/ updating of existing flood runoff model to cover whole catchment ・Elaboration of IFAS ・Development of inundation analysis model
7	Issuance of flood information	・Development of more reliable means for rapid transmission of flood information ・Increase of monitoring stations (in scarce river basins)
8	Post-flood investigation	・Close coordination among three Sections in HMD with flexible assignment and rotation shall be encouraged.
9	Public information and education drive	・Coordination with OCD R2 and LGUs shall be strengthened.
10	Telemetry and telecommunication	・Development of standards for procurement of FFWS equipment is necessary. ・Reliable telecommunication systems shall be established. ・Telecommunications for information dissemination from Tuguegarao Sub-center to PDRRMCs shall be enhanced.
11	Flood drills	・(Activities have just started from 2013 in conformity with recommendation of the former JICA TCP)

Source: Study Team

(2) Identification of Development Needs (Pasig-Laguna de Bay River Basin)

It should be noted that several monitoring systems already have been established in the Pasig-Laguna de Bay River basin such as EFCOS (JICA), KOICA and NOAH. Further, other initiatives of the UNDP/AusAID (Ready for GMMA) and the UNDP/CIDA (Resilience Project) also include components of flood early warning system in the basin. PAGASA is currently integrating all initiatives under KOICA, CIDA, AusAID, and EFCOS to issue flood information for all stakeholders. PAGASA envisages monitoring of all hydrometeorological data in the GMMA to be shared with LGUs. Under such circumstances, in particular, the following development needs should be taken into consideration:

1) PAGASA will take responsibility for observation and operation of all monitoring systems in GMMA including data management.

2) Under the Resilience Project, 22 telemetered automatic rain gauges and one water level gauge are to be established. As of end April, 19 rain gauges were already installed and the water level gauge was placed at San Mateo in Rizal Province.

3) PAGASA recently conducted the following activities under the Resilience Project in accordance with the report prepared by PAGASA HMD:

- Training of caretakers/observers :March 3-6, 2013
- Tour of PAGASA facilities by Rizal and Metro Manila DRRM representatives, Trainee-caretakers/observers, Resilience Project members :March 7, 2013
- Signing of Memorandum of Agreement and Press Conference :March 7, 2013
- Simultaneous Flood Drill :March 7, 2013 (Nangka, Marikina/Bagong Ilog, Pasig/San Roque, Cainta)

4) The Project NOAH has already deployed 13 rain gauges and 28 water level gauges in the basin.

Future Development Needs (Pasig-Laguna de Bay River Basin)

Job Category		Future Development Needs
1	Basin/river system monitoring	・Density of monitoring stations increased drastically by NOAH. Classification of existing gauging stations might be required for appropriate maintenance.
2	Data collection for flood forecasting	・Effective system for data processing, transferring and transposing to flood information will be necessary.
3	Database management	・Integration of several database systems of KOICA, EFCOS, NOAH, UNDP/AusAID (Resilience Project) is crucial.
4	Discharge measurement	・Periodical measurement shall be encouraged by newly procured equipment of ADCP.
5	Assessment and update of Flood Warning Water Levels	・Uniform definitions of warning water levels shall be applied. Substantial review and update of the water levels based on the recent occurrence of floods is essential at key monitoring stations.

6	Flood forecasting	・Flood runoff model has been developed by UP under the Project NOAH. PAGASA will need to judge whether it is usable for flood forecasting proposes or not.
7	Issuance of flood information	・Consistent rules and manners to issue the flood information to the local people, who might require anticipated movement of water levels with rainfall, shall be examined.
8	Post-flood investigation	・Conduct of survey without exception will be encouraged.
9	Public information and education drive	・Experiences in the Resilience Project shall be repeated with LGUs.
10	Telemetry and telecommunication	・Integration of NOAH's stations under PAGASA HMD with shifting ASTI's function including human resources to PAGASA (to be further examined).
11	Flood drills	・Under the Resilience Project, flood drills were conducted involving LGUs integrating with issuance of flood information as conducted in the Former JICA TCP at Angat and Magat Dam Sites.

Source: Study Team

11.5 Identification of Items for Future Development Plans

Based on the case studies up to the previous Section, the items for future development were preliminarily studied through in accordance with the following priorities:

Plan A (1st): Plan for new development of FFWS (non-telemetered river basins) aiming at Level 1 system

Plan B (2nd): Plan for enhancement and improvement of telemetered river basins (five river basins with existing FFWS/ FFWSDO) to Level 3

Plan C (3rd): Plan for upgrading from Level 1 to Level-2 & 3 at non-telemetered river basins

The Plan A is the highest priority and the Plan C is the lowest. The tentative components of the three candidate Plans are tabulated in Tables 11.5.1 to 11.5.3.

For the preliminary study on future development plans, a combination of components and river basins selected from Plans A and B will be possible depending on availability of budget, allowable time frame, and appropriate scheme of assistance, etc. Further, in principle, Plan C will be undertaken after completion of Plan A.

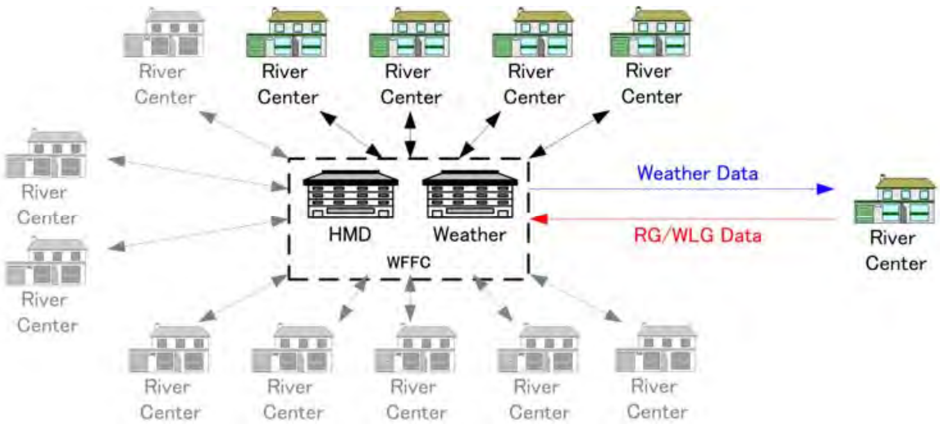
CHAPTER 12 PROPOSED ACTIONS FOR FUTURE DEVELOPMENTS

12.1 Concepts of Proposed Actions for the Expansion of PAGASA FFWS Target Areas

12.1.1 Approach

PAGASA is expanding its coverage area of meteorological and hydrological monitoring from five to 18 major river basins. The existing stand-alone monitoring systems, which are PABC FFWS/FFWSDO system, EFCOS, KOICA-II, and so on, have been constructed separately and operated independently. In order to achieve the goal of the future expansion plan, implementation approach of the monitoring network set out below is to be deployed at first.

(1) Improvement of Central and Local Monitoring Networks: Integration of the existing in-situ monitoring systems (Hydrometeorology Division and Weather Division) and combination with remote monitoring systems (satellite systems and ground rainfall radars) are both necessary. Effective centralization of monitoring data and localized monitoring and analysis will be required before starting the expansion plan. To be functional as the main operation center, WFFC needs to collect all monitoring data and analyze the nationwide situation of rainfall and flood efficiently and effectively. On the other hand, the River Centers need to receive the same data as the WFFC, to analyze local rainfall and flood situations, and to communicate with LGUs. Therefore, remote monitoring data should be sent to the River Centers.



Source: Study Team

Anticipated Image of Central and Local Monitoring Networks

(2) Modification of the Existing Systems: The said stand-alone systems were installed by the donor projects. For stable and effective operation of these systems, PAGASA should conduct not only maintenance but also modification and updating of the systems to meet the transformation of the natural conditions of the rivers.

PAGASAplans to establish monitoring systems in 13 new river basins taking into consideration the limited budget and human resources of PAGASA and donors. The procedure of the establishment may be different from the experiences of the five major basins. The development of the systems should be conducted in a step-by-step manner, and might be in a multi-vendor environment due to limited resources.

Necessity of institutional arrangements set out below is identified to operate the newly developed FFWS efficiently and effectively..

(1) Common Rules for Operation of FFWS among Related Agencies: Unified warning standards and operation manuals which can be applied among PAGASA and the rerated agencies should be prepared for the new 13 target river basins.

(2) Organizational Capacity Strengthening of PAGASA and Related Agencies: The capacity development of staff of PAGASA and related agencies should be conducted because the present staff capacity is not enough to handle the new systems. The close communication with related agencies is also important.

12.1.2 Framework of Future Actions

To materialize the future requirement, the four categories of framework are formulated. Category A is improvement and integration of the existing systems. Category B is direct actions for the new 13 river basins, but it is planned as stepwise. Category C is setting rules for operation of FFWS to establish the new FFWS for 13 river basins. Category D is the capacity development of PAGASA and the related agencies, and strengthening the communication among related agencies.

The actions under Category A are mostly prerequisite actions to materialize new 13 FFWSs. The actions under Category C and D are supporting actions for establishment of new 13 FFWSs.

A. Improvement and Integration of the Existing Systems
  - A.1 Combination of Remote and In-situ Monitoring System; refer to Section 12.2
  - A.2 Modification and Updating of the Existing System; refer to Section 12.3

B. Establishment of Future FFWS for Respective River Basins; refer to Section 12.4 and Chapter 11

C. Setting Rules for Operation of New FFWSs in 13 River Basins; refer to Section 12.5
  - C.1 Setup Localized Warning Standards
  - C.2 Development of the FFWS Operation Manuals for New River Basins

D. Capacity Development of PAGASA and Related Agencies
  - D.1 Institutional Strengthening of PAGASA HMD; refer to 12.6
  - D.2 Strengthening of Coordination Systems among Related Agencies; refer to 12.7

Arrangement of a road map for 13 River Basins is presented in Section 12.8.

12.2 [Category A.1] Combination of Remote and In-situ Monitoring System

PAGASA is expanding its coverage area of in-situ monitoring systems (i.e. rainfall gauging stations and water level gauging stations) from five to 18 major river basins. In addition, remote monitoring systems, such as satellite systems and ground rainfall radars, are also being enhanced alongside with the advancement of technology. Both in-situ monitoring systems and remote monitoring systems are essential systems to keep track of rainfall and flood situations.

As one of the modernization activities of PAGASA, the ICT Task Force has been organized. The group aims to strengthen the IT network of PAGASA. The outputs from the Weather Division, such as rainfall observation data from ground rainfall radar, can be seen in WFFC and PRSDs thanks to the contribution of the Task Force. In Tuguegarao, the Cagayan River Center and the Northern Luzon PRSD are located in the same building, so the staff can easily monitor both remote and in-situ monitoring systems. The other river centers and new river centers should also monitor both remote and in-situ data. In this context, the Study Team recommends the following:

12.2.1 Strengthening of Communication Link between WFFC and River Centers

The communication link between WFFC and River Centers has been constructed to transfer the observation data from River Centers to WFFC. However, transferring the observation data from Weather Division to River Centers is also essential.

[A.1.1] Communication Link for the Bicol and Cagayan River Basin

For the river basin in Cagayan there are three solutions. One is to rehabilitate the existing multiplex radio link which shut down due to interference from mobile phones. The second is to share IP-VPN circuits currently being tested and operated by the ICT Group of PAGASA for transmission of weather images from Weather and Flood Forecasting Center (WFFC). The third solution is to adopt a satellite communication which is operated by a carrier or government organization in the Philippines taking into consideration the costs involved.

[A.1.2] Communication Link for the River Basins without FFWS

The public line telephone sometimes cannot be used due to landline problems and convergence of traffic when disasters occur. Therefore a dedicated line should be considered for future development of transmission and dissemination of data. There are several methods of transmission now available such as satellite communications, digital UHF/microwave radio links, and IP-VPN leased from telecommunication carries. In view of cost and performance, the most appropriate solution should be further discussed.

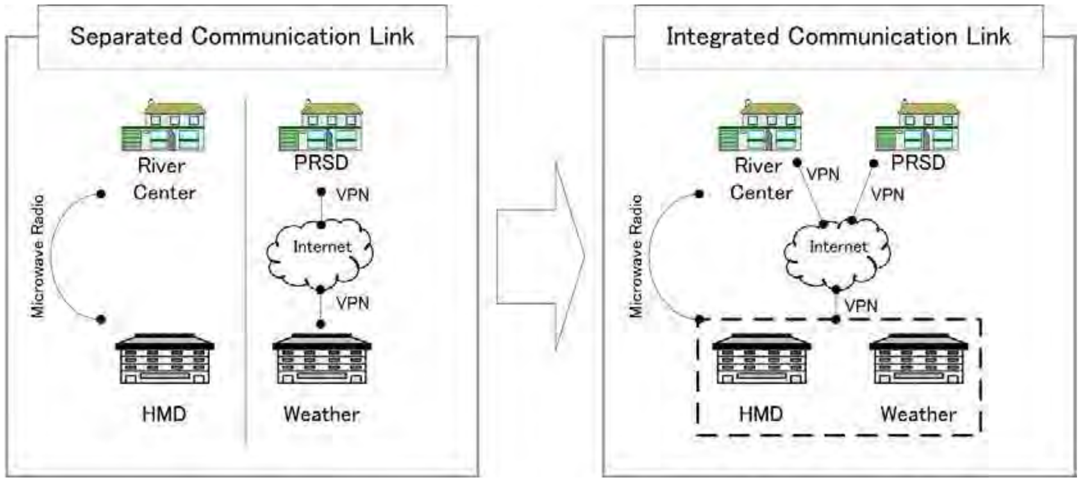
[A.1.3] Further Improvement of Communication Link for Monitoring System

- The Pampanga and Agno FFWS established with the assistance of Japan shall be utilized continuously with the provision that PAGASA performs proper operation and maintenance.
- The status of the Cagayan and Bicol FFWS shall be monitored after the completion of improvement projects.
- Equipment for FFWSDO which have deteriorated shall be rehabilitated or improved.
- The existing telecommunication systems for resilience FFWS shall be redundant, robust, and responsive.
- Adoption of the telecommunication system (leased line or dedicated line) for backbone network, which is connected to the PAGASA WFFC and the river centers/PRSD, shall

be examined referring to the state-of-the art technology and running cost (initial investment cost).

12.2.2 Integration of IT Network of Weather Division and Hydrometeorology Division

Presently the IT network of Weather Division and Hydrometeorology Division is separate. The network should be integrated to achieve a strengthened communication link between WFFC and River Centers; otherwise, the two communication links for weather data and hydrometeorology data must be transported to WFFC through different networks. These should be integrated as illustrated below and be operated in redundancy.



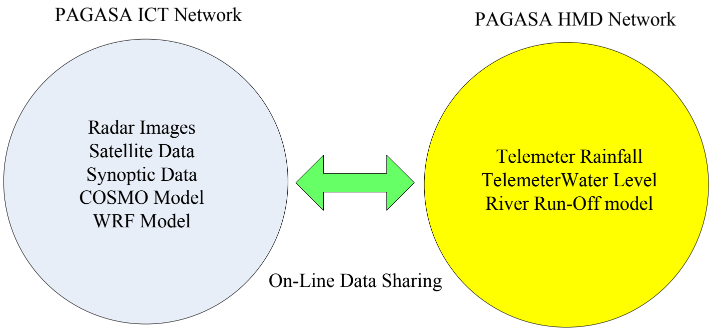
Source: Study Team

Integration of IT Networks

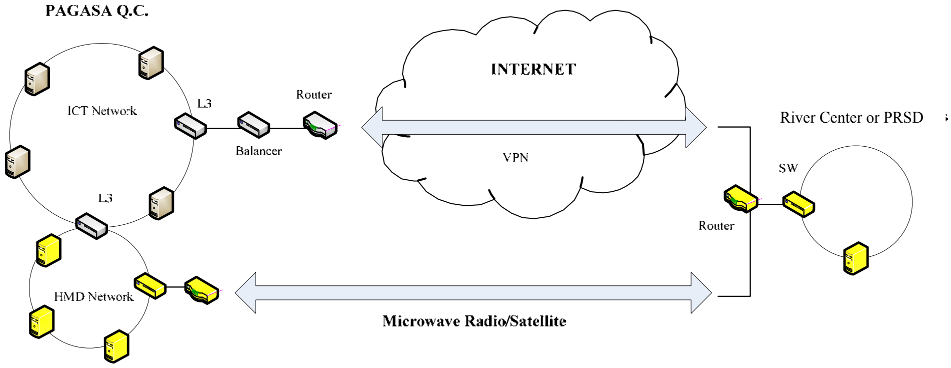
The PAGASA ICT is still a fledging, therefore the following should be noted to improve the integrity and reliability of the system.

[A.1.4] Integration of PAGASA Networks

The PAGASA HMD has its own IP network dedicated to FFWS systems. This network, however, is a closed system and is physically separated from the ICT network of PAGASA. It is recommended that the HMD network be integrated into the ICT network in the future to accomplish on-line and real-time data sharing. The rainfall and water level data obtained in the River Centers will be then transported to the PAGASA MOC through the ICT networks as shown in the following figure.



- On-line and real-time data sharing
- Establishment of weather database in future process
- River Center connection with PAGASA HMD via PAGASA ICT networking



Source: Study Team

Proposed Integration of HMD Network into Future PAGASA ICT

[A.1.5] PAGASA ICT Security Policy

PAGASA should establish a security policy to protect its own network system from external computer threats.

[A.1.6] Further Improvement of PAGASA ICT

- The core network equipment, such as the Load Balancer and the Core Router/Switch, is not configured in redundant operation. It is uncertain whether the system availability will be maintained as it is initially designed or not. The core network equipment should be duplicated in operation.
- The system still seems to be vulnerable to intrusions and threats by computer viruses, because PAGASA ICT does not have a Unified Threat Management System - such security devices as firewall, IDS, and IPS which are now widely available in the market. The system should be properly protected from external attacks.

- The non-break power packages feed the network equipment individually and they are not consolidated as a power supply system. They should be designed to upgrade the power supply's system reliability.

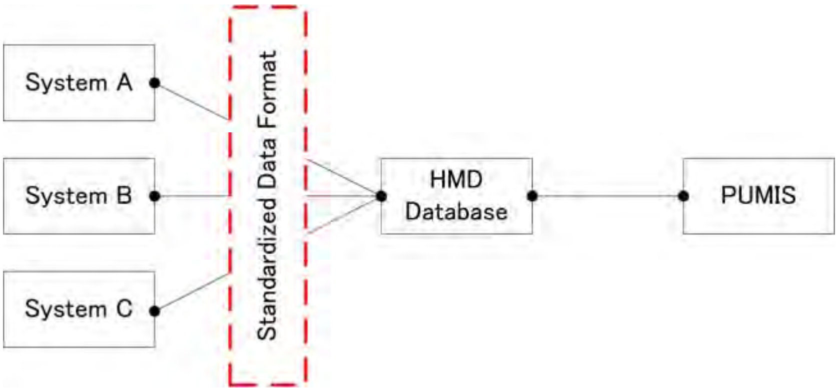
12.2.3 Development of PAGASA Database

[A.1.7] Integrate the Monitoring Data in the Hydrometeorology Division

The in-situ monitoring systems in five major basins are constructed separately. This makes it difficult to handle and analyze the data. PAGASA is going to establish the database system as PAGASA Unified Meteorological Information System (PUMIS). HMD should set up the integrated database system of in-situ monitoring data for connection with PUMIS.

[A.1.8] Standardize the Data Format

Each monitoring system vendor has its own data format, which cannot be opened to the public for the protection of its copyright. Considering the situation, PAGASA should standardize the data format to connect each monitoring system to the database, so as to achieve integration of monitoring data.



Source: Study Team

Standardized Data Format for PAGASA Database

12.2.4 Remote Monitoring for the Mindanao or Agusan River Basins

[A.1.9] Application of GSMaP and IFAS

In sites where installation of gauges is difficult due to security conditions, such as the Mindanao or Agusan River basin, remote monitoring system becomes crucial. The trainings on GSMaP and IFAS, which are satellite rainfall data and rainfall runoff model respectively, have been conducted in the Cagayan and Pampanga River basins. The same approach should be also tried in the Mindanao or Agusan River basin.

12.3 [Category A.2] Modification and Updating of the Existing Systems

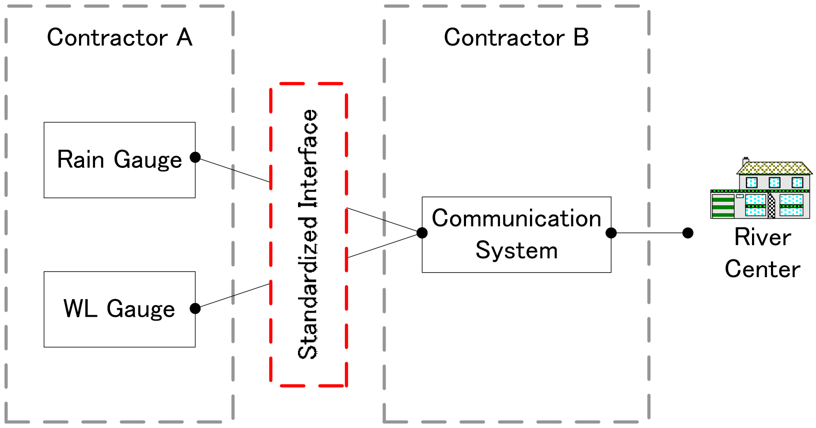
[A.2.1] Modification of the Existing Systems

Any monitoring system shall be modified or updated to cope with the present natural conditions. However, currently once the system has been installed, appropriate updating seems difficult under the current circumstances of HMD. For instance, the H~Q curves and Flood Warning Water Levels at gauging stations should be appropriately reviewed and modified at certain timing considering flood occurrences. Further, the results shall be reflected in the indication on monitors through the changes in the program/software of the computer systems.

12.4 [Category B] Establishment of Future FFWS for Respective River Basins

In order to smoothly and firmly accomplish the expansion of FFWS to the 13 major river basins, in principle, development by stage is essential as described in Chapter 11. Three levels of target (Level 1, 2 and 3) were tentatively set depending on the current situation of the systems. Further, standardization of equipment interface is another crucial factor to expedite expansion successfully.

Previously, a limited number of the contractors were involved in the existing FFWS and FFWSDO systems. However, several more may join for the establishment of the new 13 FFWS systems. The contractors for the gauges and communication systems can be different. PAGASA should standardize the interface of equipment to be supplied under multi-vendors environment. In addition to the above, standardization of the equipment is an important issue for PAGASA with the views of proper procurement procedure and operation/maintenance works.



Source: Study Team

Standardization of Interface for Telemeter Equipment

[B.1] Stage-wise Development of FFWS in Target River Basins

Three levels of accomplishment for setting the development target were examined and proposed in the current Study. Level 1 is a simple set-up with minimum number of monitoring stations, and also with communication link to LGUs. Level 2 assumed that the telemetry system to connect gauging stations and River Flood Forecasting and Warning Center (RFFWC) is established. Further, monitored records will be transferred from RFFWC to PAGASA WFFC on real time basis. On the other hand, at the stage of Level 3, flood runoff model and inundation analysis model will be developed based on the accumulated monitoring records. Further explanation is presented in Section 11.5.

[B.2] Proper Selection of Water Level Sensor Type

The many floating type and sensing pole type (lead switch type) gauges to measure water level in the rivers were installed in the old FFWS, namely Pampanga FFWS and ABC system as mentioned in Chapter 8. Most of the equipment deteriorated due to the exceeding of their lifetime. Considering the cost and accuracy, pressure type water level sensors were installed to replace the old floating and sensing pole type gauges since 2009 through JICA grant aid projects. The quartz type water level sensors have been installed for the measurement of reservoir water levels in FFWSDO projects which require high accuracy and long range of water level measurements with more than 70 m.

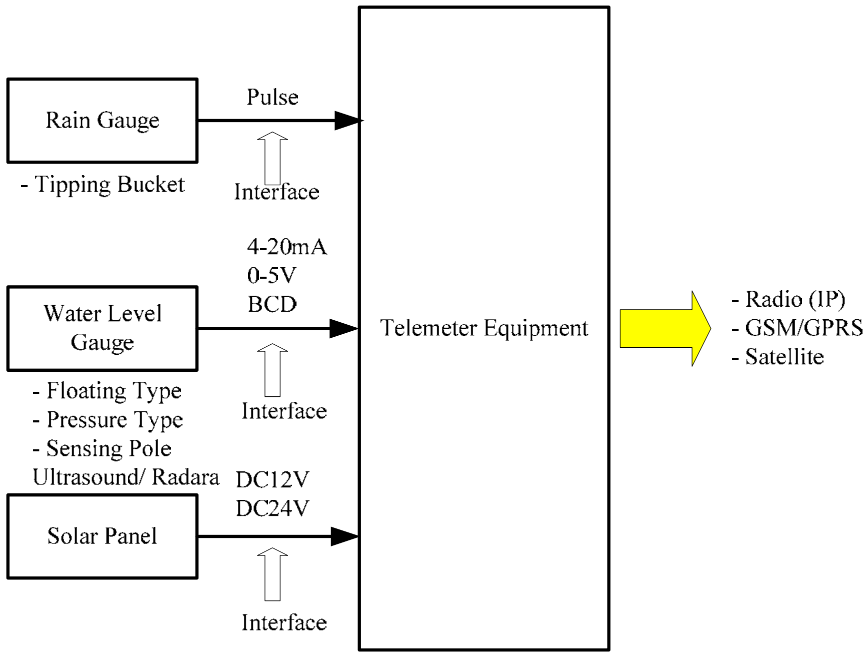
On the other hand, the ultrasonic and laser type sensors have been recently installed in bridges by Project NOAH, as well as by KOICA.

The type of the water level sensor shall be selected taking into consideration the condition of installation sites. In addition, the installation sites should be selected to measure water level appropriately from the view point of hydrology.

[B.3] Standardization of Telemetry Equipment

The Study Team tentatively contemplated a design concept of standardization of the equipment such as the rain gauge, water level, data logger/ RTU, and telecommunication as shown below. The following specifications could be recommended as the standard equipment:

- Output of rain gauge: pulse
- Output of water level sensor: 4-20 mA
- Operating voltage: DC 12 V
- Data transmission system: VHF/UHF radio (main) and GSM (back-up) or Satellite



Source: Study Team

Design Concept of Standardization of the Equipment (Tentative)

BCD interface between water level and the telemetry equipment has been used in the existing FFWS and FFWSDO projects which were funded by OECF/JICA. BCD interface is the technical standards in Japan. The interface shall be updated adopting international standards such as 4-20 mA.

12.5 [Category C] Setting Rules for Operation of New FFWSs in 13 River Basins

[C.1] Setup Localized Warning Standards

Localized FFWSs need to establish the warning standards for rainfall and water level of monitoring stations, which will be incorporated in the new systems for new target river basins in the future. Such standards/ rules shall be examined for application in the respective river basins considering hydrological characteristics, socio-economic conditions, and land use, aimed to the accomplishment of Level 1 as mentioned in Clause 11.5.4.

[C.2] Development of the FFWS Operation Manuals for New River Basins

Regarding the transmission and dissemination of monitored data for the river basins in Agno and Pampanga, PAGASA/HMD currently follows the rules and procedures stated in the manuals: The Dam Discharge Manual and The Operation Manual of Flood Forecasting and Warning System for River Basin, revised and updated in 2012. The methodology stated in the manuals should be developed for the other river basins, as well, in order to accomplish this objective.

12.6 [Category D.1] Institutional Strengthening of PAGASA HMD

As the number of monitoring systems in new river basins increases, the quantity of HMD work will correspondingly multiply. Therefore, the institutional strengthening of HMD by means of the employment of new staff and capacity development becomes a prerequisite. Currently, PAGASA HMD sends the staff abroad to undertake short and long term training courses to enhance their technical knowledge. These capacity-building efforts are organized and financially supported by donors and/or host countries. HMD is aggressively encouraging staff training to cope with the increase of tasks related to FFWS work. Institutional strengthening is one of the most important issues for PAGASA, and the following is essential measures leading to a better performance of HMD:

[D.1.1] Capacity Development of Staff of HMD and Concerned Agencies

As mentioned in Clause 11.2.1, PAGASA created the “Satellite Technology Application Unit (STApU)” attached to the Office of the Division Chief on April 01, 2013 in order to cope with the rapid increase of the demand for handling applied technology using satellite and remote sensing. Five personnel who belong to the FFWS Section were nominated to staff of this Unit allowing responsibility for the handling of dual tasks. On the other hand, fundamental needs on basic level of applied hydrology are still in demand not only in PAGASA but also in other agencies such as NWRB, MWSS, NPC, NIA, DPWH, and OCD. PAGASA needs to continue its efforts to take an initiative in this field. In effect, further enhancement of training of staff in terms of capacity development should be encouraged and prioritized in PAGASA.

[D.1.2] Capacity Development of Staff of New River Flood Forecasting and Warning Centers (RFFWCs)

In some new RFFWCs, new staff shall be employed in the respective regions and provinces. In such a case, the recruitment of highly educated technical staff will be rather difficult. Therefore, training on basic meteorology and hydrology, in particular monitoring and data recording, will be highly demanded. In fact, according to HMD, three to four personnel will be hired from PDRRMC of Davao del Norte to serve as staff of the RFFWC in Tagum-Libuganon. Systematic training mechanisms shall be established immediately in HMD so as to strengthen the local services through appropriate flood monitoring and information dissemination activities by the concerned RFFWC.

[D.1.3] Organizational Reform of HMD

As mentioned in "Combination of Remote and In-situ Monitoring System" in Section 12.2, data management system for flood forecasting and warning operation in HMD shall be revised and modernized by means of ICT. Hence, skilled ICT engineers and technicians are urgently needed for a full implementation of PAGASA ICT's scope. Moreover, geodetic survey expert(s) for ground survey/leveling for installation of water level gauges and staff gauges shall be employed at the earliest opportunity. Special priority should be given to the human resource capacity building of the Hydrological Telemetry Section HMTS. In addition, recruitment of new staff with the appropriate technical background will be a prerequisite as well.

In this connection, currently allocated tasks and responsibilities of the existing three Sections, namely FFWS, HMDAS, and HMTS, should be substantially reviewed and updated.

12.7 [Category D.2] Strengthening of Coordination Systems among Related Agencies

[D.2.1] Authorization and Activation of JOMC

JOMC, established in 1992, currently continues to perform its roles in the discussion and decision on remedial measures for the FFWS/ FFWSDO all over the Country. Although PAGASA formulated a strengthening plan of JOMC though the former JICA TCP, which was completed in November 2012, it seems that the plan needs to be updated and/or reformed to expedite accomplishment of activities. In particular, the JOMC Agreement prepared on 1992 by member agencies shall be fully reviewed and updated through a reflection on current circumstances and actual operation of the systems. The updated Agreement shall be authorized by the Office of the President (or other appropriate agency or committee) in order to establish an enforcement of decisions made by JOMC.

[D.2.2] Strengthening of Linkage between RFFWCs and LDRRMCs

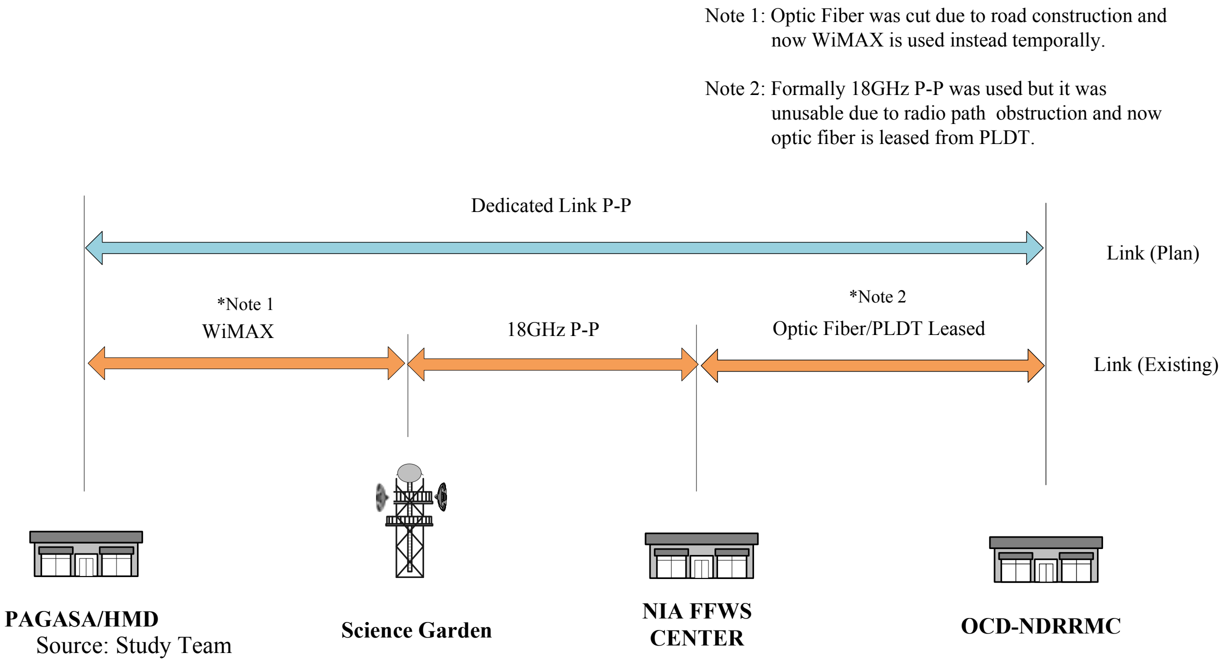
HMD is now undertaking "River Center Project" to expand the coverage of FFWS in five river basins to other 13 river basins. It is initiating the construction of 13 river flood forecasting and warning centers (RFFWC) particularly from the river basins in Mindanao[1]. In order to achieve monitoring and flood operations to send the required flood information to

[1] HMD is expediting the bidding procedure to establish the river centers in three river basins as the first batch, namely in Tagum-Libuganon, Mindanao (Cotabato City), and Buayan-Malungon (General Santos). Subsequently, the Davao, Agusan, and Agus-Lake Lanao River basins will follow as second group.

LGUs (LDRRMCs), close coordination between RFFWC and LDRRMCs is important. This is especially needed at the initial stage of FFWS development in new river basins, since the monitored data may not be transmitted to WFFC in Quezon City. Flood information issued by RFFWCs will be of vital importance and meaning for the local people affected by torrential rainfall and floods.

[D.2.3] Improvement of the Dedicated Communication Link between PAGASA/HMD and OCD-NDRRMC

The data communication link between PAGASA/HMD and OCD-NDRRMC should be overhauled for redundancy in operation because the communications between them have such a crucial importance from the viewpoint of disaster prevention and relief. As indicated below, the existing link is complicated and not consolidated; therefore another dedicated link as shown in the figure should be constructed for redundancy in operation.

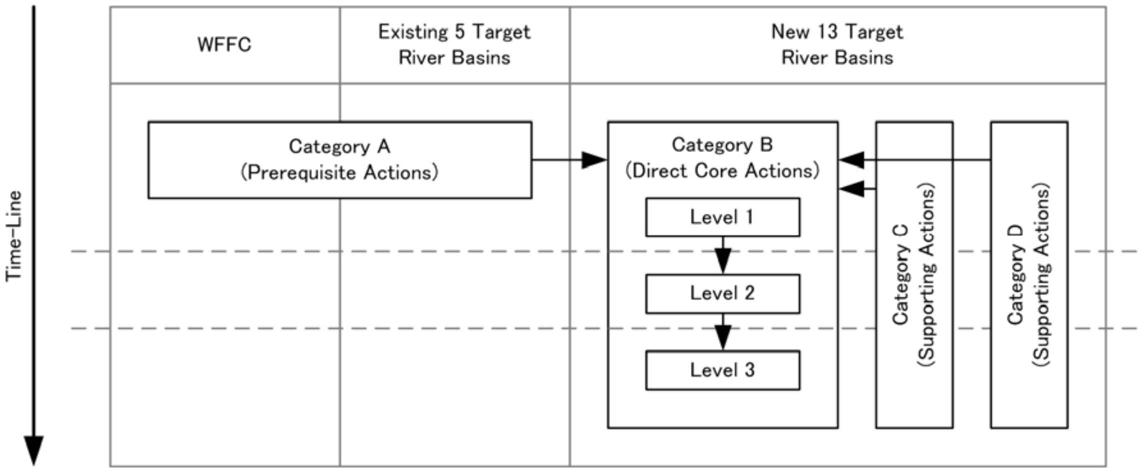


Source: Study Team

Existing and Proposed Data Communication Link between PAGASA/HMD and OCD-NDRRMC

12.8 Roadmap for Future Developments

PAGASA is recommended to prepare a road map to materialize the expansion plan of new 13 river basins taking into consideration its limited budget and human resources with the following four categories. Category B is the direct core actions of the expansion plan which is planned as stepwise. Category A, which is improvement and integration of the existing stand-alone systems, is prerequisite to start Category B. Category C and Category D are supporting arrangements required for PAGASA and related agencies to materialize Category B in practice. The time-frame of proposed actions is shown below, and the more detail road map should be prepared by PAGASA.



Note:

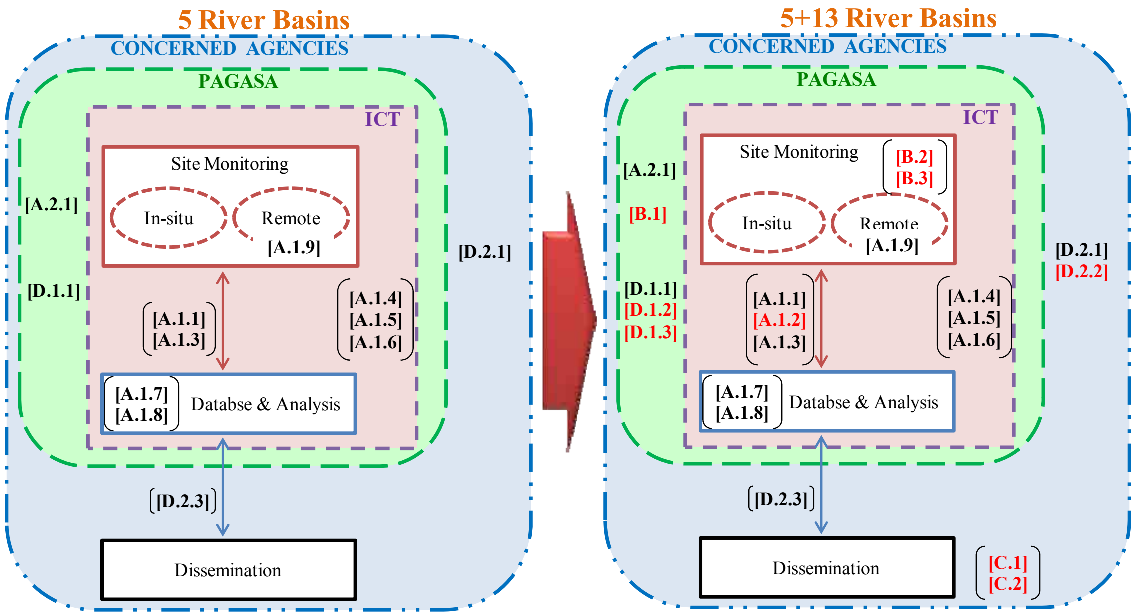
A. Improvement and Integration of the Existing Systems
B. Establishment of Future FFWS for Respective River Basins
C. Setting Rules for Operation of New FFWSs in 13 River Basins
D. Capacity Development of PAGASA and Related Agencies

Source: Study Team

Time-frame of Proposed Actions

12.9 Summary of Proposed Actions

The position of each action in the work flow of FFWS is shown in the following figure. The left side of the figure shows the improvement of the existing FFWS workflow in the five major basins. The right side of the figure presents the workflow in the expanded target river basins; i.e., the existing five river basins and the new 13 river basins.



Source: Study Team

Framework	Proposed Actions
A. Improvement and Integration of the Existing Systems	
A.1 Combination of Remote and In-situ Monitoring System	A.1.1 Communication Link for the Bicol and Cagayan River Basin A.1.2 Communication Link for the River Basins without FFWS A.1.3 Further Improvement of Communication Link for Monitoring System A.1.4 Integration of PAGASA Networks A.1.5 PAGASA ICT Security Policy A.1.6 Further Improvement of PAGASA ICT A.1.7 Integrate the Monitoring Data in the Hydrometeorology Division A.1.8 Standardize the Data Format A.1.9 Application of GSMaP and IFAS
A.2 Modification and Updating of the Existing Systems	A.2.1 Modification and Updating of the Existing Systems
B. Establishment of Future FFWS for Respective River Basins	
	B.1 Stage-wise Development of FFWS in Target River Basins B.2 Proper Selection of Water Level Sensor Type B.3 Standardization of Telemetry Equipment
C. Setting Rules for Operation of New FFWSs in 13 River Basins	
	C.1 Setting of Localized Warning Standards C.2 Development of Unified Operation Manuals among Related Agencies for New River Basins
D Capacity Development of PAGASA and Related Agencies	
D.1Institutional Strengthening of PAGASA HMD	D.1.1 Capacity Development of Staff of HMD and Concerned Agencies D.1.2 Capacity Development of Staff of New River Flood Forecasting and Warning Centers (RFFWCs) D.1.3 Organizational Reform of HMD
D.2 Strengthening of Coordination Systems among Related Agencies	D.2.1 Authorization and Activation of JOMC D.2.2 Strengthening of Linkage between RFFWCs and LDRRMCs D.2.3 Improvement of the Dedicated Communication Link between PAGASA/HMD and OCD-NDRRMC
Arrangement of a road map for 13 River Basins	

<< IDENTIFIED ISSUES AND RECOMMENDATIONS >>

Issues	Reccomendations
Chapter 7	Chapter 12
7.1 Meteorological and Hydrological Monitoring	12.1 Concepts of Proposed Actions for the Expansion of PAGASA FFWS
(1) Setting Target for Installation of Rainfall and Water Level Stations	Target Areas
(2) Additional Rainfall and Water Level Gauging Station by Project NOAH	12.1.1 Approach
(3) Duplication of Rainfall and Water Level Stations	12.1.2 Framework of Future Actions
(4) Reliability of Monitoring Data	
(5) Classification of Stations	12.2 [Category A.1] Combination of Remote and In-situ Monitoring System
(6) Sharing of Tide Level	
7.2 Data Management	12.2.1 Strengthening of Communication Link between WFFC
(1) Automation of Data Management	and River Centers
(2) Integration of Observed Data	[A.1.1] Communication Link for the Bicol and Cagayan River Basin
(3) Strategy of Quality Control of Archived Data	[A.1.2] Communication Link for the River Basins without FFWS
7.3 Survey Works	[A.1.3] Further Improvement of Communication Link for Monitoring System
(1) Coordination among Related Agencies	
(2) Archive of River Cross Section Data	12.2.2 Integration of IT Network of Weather Division
(3) Connection of Water Level Monitoring and River Cross Sections	and Hydrometeorology Division
(4) Quality of Survey Works	[A.1.4] Integration of PAGASA Networks
(5) Update of River Cross Section Data	[A.1.5] PAGASA ICT Security Policy
(6) Target Stations for Discharge Measurements and Work Demarcations	[A.1.6] Further Improvement of PAGASA ICT
7.4 Flood Forecasting Models	
(1) Expansion of FFWS Target Basins and Stepwise Approach	12.2.3 Development of PAGASA Database
of Model Development	[A.1.7] Integrate the Monitoring Data in the Hydrometeorology Division
(2) Coverage Area of Existing Flood Runoff Models	[A.1.8] Standardize the Data Format
(3) Further Calibration of Existing Flood Runoff Models	
7.5 Inundation Analysis	12.2.4 Remote Monitoring for the Mindanao or Agusan River Basins
(1) Coordination among Related Agencies	[A.1.9] Application of GSMaP and IFAS
(2) Stepwise Approaches for Establishment of Inundation Forecasting Model	
(3) Detail Elevation and River Cross Section Data	12.3 [Category A.2] Modification and Updating of the Existing Systems
(4) Trainings on Remote Sensing Technologies	[A.2.1] Modification of the Existing Systems
7.6 Post Flood Survey	
(1) Improvement of Operation Manual of FFWS	12.4 [Category B] Establishment of Future FFWS for Respective River Basins
(2) Sharing Good Examples	[B.1] Stage-wise Development of FFWS in Target River Basins
(3) Collaboration with LGUs	[B.2] Proper Selection of Water Level Sensor Type
(4) Further Implementation of Post Flood Surveys	[B.3] Standardization of Telemetry Equipment
Chapter 8	
8.1 Issuance of Flood Information/Warning	12.5 [Category C] Setting Rules for Operation of New FFWSs in 13 River Basins
(1) River basins with existing FFWS (Cagayan, Agno, Bicol and Pampanga)	[C.1] Setup Localized Warning Standards
- Updation of warnig WL (FFWS)	[C.2] Development of the FFWS Operation Manuals for New River Basins
- Refreciton of updated warning WL on the monitoring system (FFWSDO)	
(2) Pasig-Marikina River Basin	12.6 [Category D.1] Institutional Strengthening of PAGASA HMD
- Methodology to determine waring WL	[D.1.1] Capacity Development of Staff of HMD and Concerned Agencies
(3) New river basins	[D.1.2] Capacity Development of Staff of New River Flood Forecasting
- Determination of warning WL	and Warning Centers (RFFWCs)
8.2 Coordination System among Concerned Agencies	[D.1.3] Organizational Reform of HMD
(1) River basins with existing FFWS (Cagayan, Agno and Pampanga)	
(2) Bicol River basin	12.7 [Category D.2] Strengthening of Coordination Systems
- Strengthening river center	among Related Agencies
(3) Pasig-Marikina River basin	[D.2.1] Authorization and Activation of JOMC
- Demarcation between HMD and NCR	[D.2.2] Strengthening of Linkage between RFFWCs and LDRRMCs
(4) New river basins	[D.2.3] Improvement of the Dedicated Communication Link
- Strengthening JOMC	between PAGASA/HMD and OCD-NDRRMC
- Coordinaiton of PAGASA and OCD	
- Coordinaiton of river center and LGU	12.8 Roadmap for Future Developments
Chapter 9	
9.1 Existing Communication System and Equipment	
for Meteorological/Hydrological Monitoring System	
(1) KOICA-II	
- Low durability of equipments	
(2) NOAH Project	
- Vandalism	
- Rusting	
(3) Telemetry stations in the existing FFWSDO	
- Rehabilitation	
(4) Existing backbone telecommunication network	
- Rehabilitation	
(5) Utilization of the existing FFWS	
- Data sharing and archiving	
- Capability to modify the system	
9.2 Operation and Maintenance of Existing Equipment	
- Shortage of staff for O and M of ASTI equipments	
- Shortage of capacity on O and M on data server and other computer systems	
9.3 Transmission and Dissemination of Monitored Data	
- Establishment of dedicated communication link for Bicol and Cagayan	
- Establishment of dedicated communication link for new river basins	
9.4 Communications System	
(1) Inadequate Means of Communications Networks among municipal	
and barangay members in remote regions and provinces	
(2) Unreliable Communications at MDRRMC	
(3) Dedicated Communications Network between PAGASA/HMD	
and OCD-NDRRMC	
(4) Communications dependent on Telecom Carriers and Providers	
(5) One way Communications	
9.5 Currently Used Information Communication Technology (ICT)	
- Skilled ICT engineers and technicians	
- Security policy	
- Integration of network	
- Improvement of core network equipment	
- Protection from external computer attacks	
- Non-break power packages	

Issues to be solved by OCD

Source: Study Team

Tables

Table 1.5.1 Current Status of Data/Infromation Collection (1/2)

Items for "Collection and Analysis of Related Data and Information"	Detailed Issues	Data/Information Required	Data/ Information Collected
(1) Current Policy, Plan, and Program of the Government of the Philippines and On-going/Future Projects by Donors and by the Philippines	National policy and development plan for disaster management sector	Implementation Program, Minutes of Agreement, etc. (hearing to the agencies concerned)	- Philippine Development Plan 2011-2016 - Republic Act N.101211 - DPWH's Memorandum titled by "Prioritization Criteria for Flood Control Projects" (2010.7.21)
	Assistance policy of the donors in disaster management sector	Policy of assistance by countries, Country Reports and preceding/handout of official conferences/symposium, etc.	- Country Assessment Report for the Philippines (UNISDR) -Program Fromation Survey in the Philippines（2008.3） -Country Assistance Program for the Philippines（2008.6） -Coutrny Assistance Policy for the Philippines（2014.4）
	Policy and direction of DOST-PAGASA	Literature and reports of policy, etc.	- A series of infomration on "Project NOAH"
	On-going and future projects by the donors	Progress Reports, Implementation Programs, etc.	- A series of interviews to the personnel concerned and reports/documents collected
	On-going and future FFWS related Projects by own finance of the Government of the Philippines	Mid-term Investment Plan by DPWH, priority project list, etc.	-Establishment of Flood Forecasting and Warning System in Majpor River Basins in the Philippines ("River Center Project") - A series of infomration on "Project NOAH"
	Disaster Risk Reduction Management Plan by the agencies concerned in the Philippines	Disaster Risk Reduction Management Plan by PDRRMC, etc.	-
	Flood management projects assisted by the donors and own finance of the Philippines	Related reports and references	-"The Study on the Nationawide Flood Risk Assessment and the Flood Mitigation Plan for the Selected Areas (Mar.2008)" -Other particular project reports prepareded by the assistance of JICA
(2) Current Status of Utilization of Existing FFWS	Availableness of NOAH rainfall and water level stations for FFWS	-	-NOAH stations will be transferred to PAGASA in the future. Data is transmitted through SMS or satellite (rainfall; 15min, water level 10min).
	Number of proposed rainfall and water level stations in future	Installation plan of new rainfall and water level stations by PAGASA	-Existing/plan of rainfall and water level stations list were collected from PAGASA and other agencies.
	Operating condition of Hydrological stations and data collecting rate	Interview from concerned agency, observed data, study report, etc.	-Operating condition of hydrological stations was confirmed by interview.
	With or without data communication network concerned FFWS	Interview from concerned agency, study report, etc.	-3 river basins (Agno, Cagayan, Pampanga) conducted by JICA TCP.
(3) Current Status of Utilization of Flood Runoff Models	Data and material of development for flood forecasting model	Daily and hourly rainfall and water level record, discharge measurement record, river cross section, river basin characteristics (principal feature of natural retarding basin, etc.)	-Information of rainfall and water level stations were collected. Information of river cross sections are requested to DWPH.
	With or without flood model and applicable scope of model	Interview from PAGASA and MMDA, etc.	-Existing flood runoff model is as follows: Cagayan: JICA TCP model, IFAS Agno: JICA TCP Cagayan: JICA TCP model, IFAS Pasig: HEC-HMS
(4) Current Status of Accumulation and Utilization of Meteorological and Hydrological Data	Rainfall, water level, and discharge records during flood	Observed hydrological record, study report, etc.	-Data collected previous study report only Cagayan, Agno, and Pampanga river basins.
	Data quality check of hydrological data	Observed hydrological record, study report, etc.	-The present condition is not conducted data quality check.
(5) Current Status of Accumulation and Utilization of River Cross Sections	Output of river cross section survey	Existing river cross section data, plan of river cross section survey	-Information of river cross sections are requested to DWPH.

Source: Study Team

Table 1.5.1 Current Status of Data/Infromation Collection (2/2)

Items for "Collection and Analysis of Related Data and Information"	Detailed Issues	Data/Information Required	Data/ Information Collected
(6) Current System for Issuance of Flood Warning	Kinds, rules, organization (senders & receivers), responsibilities, description of warning and standard forms for warning issuance	Dam Discharge Warning Manuals, Flood Warning Manuals and samples for warning issuance during actual floods (Dam Discharge Warning, Flood Bulletin, etc.)	-Rainfall warning system in Metro Manila -Flood Operation Manuals prepared by former JICA TCP
(7) Current Status of Coordination System among Concerned Agencies	Communication network and sharing of responsibilities	Rules and regulations, MOA, etc.	-As for 5 RBs with existing system- Completion Report of former JICA TCP -Interviews to PRSD-Visayas and OCD Region 7
(8) Current Procedure of Transmission of Monitored Data and Flood Information to the Concerned Agencies	Confirmation of equipment for the Transmission of Monitored Data and Flood Information to the Concerned Agencies	System Configuration Diagram / Drawing	-The communication system (HF-SSB): Availability shall be confirmed
(9) Current Status of Communication Systems	Understanding of Current Status of Community Based Early Flood Warning System	System Configuration Diagram / Drawing	-
	Understanding of Status of Dedicated Network	System Configuration Diagram / Drawing	- PAGASA: 7.5 GHz micro-wave - NGCP/NPC : Optic fiber and 7.5 GHz micro-wave
	Understanding of Status of Information Communication (IT)	System Configuration Diagram / Drawing	-Internet connection of PAGASA
(10) Current Condition of Existing Equipment and Plan for Adaptation of New Equipment for FFWS	Understanding of the Existing Equipment	System Configuration of Telemetry, AWS equipment etc	- System configuration of AWS under TCO 2 project (PAGASA)
	Understanding of Current Status of Doppler Radars	System Configuration of Doppler Radars	-Basic Design Report of Japan Grant Aid Project
	Understanding of Plan for Adoption of New Equipment for FFWS	Implementation Plan, MOA etc	- F/S for the Meteorological and Hydrological Telecommunications System Upgraded Project (USTDA March 2012), - Japan Grant Aid (Non-project) in 2013 (Provision of measuring equipment)
(11) Current System for Operation and Maintenance of Existing Equipment	Understanding of the Existing Equipment	Inventory List, Equipment Status List, O & M Manuals	-No data of Inventory list/O & M record of AWS of PAGASA nor ASTI
(12) Current Condition of inundation Analysis, Data Accumulation and Updating System	Data accumulation status for conducting inundation analysis	DEM, river longitudinal and cross sections, rainfall/discharge records, results of flood runoff analysis, H～Q curves, etc.	-Hazard and inundation maps were collected from READY Project, CTI report. Information of other maps were requested to DWPH.
	Status of development and utilization of inundation analysis models	Inundation analysis models	-Pampanga; MIKE-FLOOD by JICA TCP Pasig: HEC-RAS by UP
(13) Current and Future Issues and Risks related to All Aspects	Verification of problems and issues	All items (1) ～(12)	-
(14) Needs for Cooperation by Degree of Priority	Verification of needs for official assistance	All items (1) ～(13)	-
(15) Flood damage potential in flood prone areas	Present and future population (in flood prone areas), growth rate of population, location of urban areas, etc.	Census 2010, etc.	-Census 2010
	Major industries	Census 2010, etc.	-Census 2010
	Flood affected areas	Inundation maps (actual floods), hazard maps, etc.	-Product of "Ready Project" -FRIMP Report (Data Book)
	Numbers of casualties (deaths/missing/affected persons, inundated houses, etc.)	flood damage statistics, etc.	-Data collected from OCD-NDRRMC -Data stracted from EM-DAT
	Frequency, area, water depths, duration of inundation	Specific project reports and flood survey reports, etc.	-

Source: Study Team

Table 1.5.2 Inventory Sheet of Interview Survey

No.	Date/Time	Interviewee	Interviewer	Subject	Note
1	March 01, 2013	[NTT Data] Mr. Iso, Mr. Kuribayashi, Dr. Tsutsui	Mr. Motoki, Mr. Wasa, Mr. Azuma, Mr. Shinji	Activity of NTT Data	Dissemination of disaster information
2	March 07, 2013	[DPWH] Mr. Okuda	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma	Sharing information	Pronouncement of action plan of GOJ, Avoiding competition with other projects
3	March 07, 2013	[OCD] Mr. Kusakabe	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma	Sharing information	Organizational change
4	March 08, 2013	[CDO Study Team] Mr. Shimano	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma	Sharing information	13 new river centers, KOICA in CDO
5	March 11, 2013	[PAGASA-HMD] Dr. Susan	Mr. Nakamura (JICA), Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma	Sharing information	Priority on Mindanao, Technical assistance involving OCD, Technical corporation of remote sensing technology
6	March 11, 2013	[PAGASA-HMD] Mr. Socrates F. Paat, Jr.	Mr. Motoki, Mr. Hirota, Mr. Wasa, Ms. Morales, Mr. Pangan	IFAS	2 PAGASA staff for IFAS operation, Applying IFAS to 13 basins, ADB follow-up project
7	March 11, 2013	[NPC-FFWS] Mr. Russel A. Rigor, Mr. Parada	Mr. Hirota	Rain gauges	Rain gauges in Angat Dam, Mindanao, Northern Luzon
8	March 12, 2013	[PAGASA-HMD] Ms. Margaret P. Bautista	Mr. Hirota	Rain gauges	NORAD project, ASTI gauges
9	March 13, 2013	[PAGASA-HMD] Mr. Roy A. Badilla, Ms. Rosalie C. Pagulayan	Mr. Motoki, Mr. Wasa	Donor projects	List of donor projects
10	March 13, 2013	[PAGASA-METTSS] Mr. Erie S. Esterella	Mr. Bautista (PAGASA), Mr. Azuma, Mr. Wasa, Mr. Pangan, Mr. Celadina	ARG, AWS	PAGASA 87 ARG and 76 AWS, ASTI 98 ARG and 82 AWS, FTP server
11	March 14, 2013	[FCSEC] Mr. Jesse C. Felizardes, Mr. Jerry A. Fano, Mr. Grecile Christopher Domo, Ms. Dolopres M. Hipolito	Mr. Motoki, Mr. Hirota, Mr. Wasa, Ms. Morales, Mr. Pangan	Data in FCSEC	Water level data in DPWH BRS, F/S and M/P in 56 basins, Organizational change, Cross section in DPWH, Hazard map in MGB
12	March 15, 2013	[PAGASA-HMD] Ms. Nivagine C. Nievares	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma, Ms. Morales, Mr. Pangan, Mr. Celadina	Donor projects	JAXA project, Twin Phoenix project, River centers project, Korean project in CDO, Korean project in Pampanga, Sentinel Asia project
13	March 18, 2013	[PAGASA-Weather] Mr. Bany	Mr. Wasa	Rainfall observation	Weather forecasting, Rainfall Radar
14	March 19, 2013	[PAGASA-HMD] Mr. Oscar D. Cruz	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma, Mr. Pangan, Mr. Celadina	Donor projects	UNDP Ready Project, Ecotown Demonstration Framework Project, DRR/CCA Project
15	March 19, 2013	[PAGASA-HMD] Mr. Roy A. Badilla	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma, Mr. Pangan, Mr. Celadina	Donor projects	River Centers Project, GMMA RAP
16	March 20, 2013	[DOST-ASTI] Ms. Shanda Laura Velasquez, Mr. Rene Mendoza, Mr. John Louie D. Fabila (UP)	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma, Mr. Pangan, Mr. Celadina	NOAH project	Organization, Overview of NOAH, NOAH-ASTI gauges, Data archive, LIDAR survey, Flood analysis
17	March 22, 2013	[PAGASA] Mr. Reymond	Mr. Hirota, Mr. Wasa	Rainfall observation and warnings	Rainfall warning system for Metro Manila, Rainfall forecast, Validation of Radar
18	March 25, 2013	[UP] Dr. Lagmay, Alfredo Mahan, Ms. Jen Alconis	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma	NOAH project	Organization, Overview of NOAH, NOAH-ASTI gauges, LIDAR survey, Flood analysis, Flood warnings, Flood reporting system
19	April 01, 2013	[Japan Weather Association] Mr. Amano	Mr. Shinji	X-band MP radar, X Rain for smart phone	Current trend of application in Japan
20	April 01, 2013 April 04, 2013	[PAGASA] Mr. Paat, Mr. Perin	Mr. Azuma	KOICA system	Current issues toward actual operation for flood monitoring
21	April 01, 2013	[JICA] Mr.Nakamura	Mr. Motoki, Mr. Hirota, Mr. Wasa, Mr. Azuma, Mr.Al-Hanbali	Interim Report (Draft)	Preliminary discussions on contents of Interim Report
22	April 02, 2013	[Mitsubishi] Mr. Furui, Mr. Ozasa	Mr. Shinji	X-band MP radar, Communication system	Current trend of application in Japan
23	April 02, 2013	[Toshiba] Mr. Wada, Mr. Kobayashi	Mr. Shinji	X-band MP radar	Current trend of application in Japan
24	April 04, 2013	[JRC] Mr. Akiyama, Mr. Inoue, Mr. Makino, Mr. Hashida, Mr. Nagata, Mr. Arimura, Mr. Takagawa	Mr. Shinji, Mr. Hirota	X-band MP radar, Communication system	Current trend of application in Japan and current progress in the Philippines
25	April 17, 2013	[PAGASA-NTC] Ms. Precilla Demiton	Mr. Shinji, Mr. Paz	Frequency allocation on radio system	Available range of frequency for disaster information system
26	April 23, 2013	[PAGASA]Ms. Pagulayan	Mr. Shinji, Mr. Paz, Mr. Wasa	Collection and dissemination of information	Current issues on data collection and information dissemination system in HMD
27	April 24, 2013	[PAGASA]Mr. Jose	Mr. Shinji, Mr. Paz, Mr. Azuma	IP-VPN network, Satellite system	Actual progress to apply in PAGASA
28	April 29, 2013	[OCD] Ms. Cruz, Mr. Aquino, Mr. Caigoy, Mr.	Mr. Shinji, Mr. Paz	Communication system in OCD	Available system & network in OCD
29	June 18, 2013	[MADA] Ms.Bardo	Mr. Motoki, Mr. Wasa, Mr. Shinji, Mr. Azuma	Current status of EFCOS	Visited and interviewed at Rosario Master Control Station, MMDA
30	June 21, 2013	[NGCP] 3 Management staff	Mr. Motoki, Mr. Shinji	NGCP's development plan to connect Mindanao Grid	To confirm development plan for connection of transmission/communication line with Minadanao
31	June 25, 2013	[PAGASA] ICT Task Force members, HMD staff	Mr. Motoki, Mr. Wasa, Mr. Shinji	Current status of ICT renovation in PAGASA	Latest activities and future direction of PAGASA's ICT renovation and improvement by Task Force

Source: Study Team

Table 2.3.1 Assignment Schedule of Study Team

	Position	Name	Company	2013: 2	3	4	5	6	7	8	9	Man-month: Field	Home
Field	Team Leader/ Organization/Flood Warning	Yoshihiro MOTOKI	Nippon Koei Co., Ltd.			(75)		(15)		(30)		4.00	
Field	Meteorology and Hydrology/ Flood Runoff Model A	Shuji HIROTA	Nippon Koei Co., Ltd.		(30)							1.00	
Field	Meteorology and Hydrology/ Flood Runoff Model B	Morihiro WASA	Nippon Koei Co., Ltd.			(75)		(15)			(16)	3.53	
Field	Equipment Planning and O & M	Yasushi AZUMA	Nippon Koei Co., Ltd.			(75)		(5)			(10)	3.00	
Field	Forecasting and Warning System	Yoshiyuki SHINJI	Nippon Koei Co., Ltd.			(28)		(10)			(16)	1.80	
Field	GIS/Inundation Analysis	Ahmad AL-HANBALI	Nippon Koei Co., Ltd.			(49)					(16)	2.17	
Field											Sub-total of Field Work	15.50	
Home	Team Leader/ Organization/Flood Warning	Yoshihiro MOTOKI	Nippon Koei Co., Ltd.	(6)							(10)		0.53
Home	Meteorology and Hydrology/ Flood Runoff Model B	Morihiro WASA	Nippon Koei Co., Ltd.	(6)							(4)		0.33
Home	Equipment Planning and O & M	Yasushi AZUMA	Nippon Koei Co., Ltd.	(6)									0.20
Home	Forecasting and Warning System	Yoshiyuki SHINJI	Nippon Koei Co., Ltd.			(6)							0.20
Home											Sub-total of Home Work		1.26
Reports					Inception Report (IC/R)		Interim Report (IT/R)	Submitted			Final Report (F/R)		
Survey Stage and Total of MM				First Home Work		Seminar		Field Work			Second Home Work	15.50	1.26
												16.76	

Legend: ■ Field Work □ Home Work

Table 6.1.1 Target Areas for FFWS in Each River Basin

Name of River Basin		Target Areas for FFWS	Status of Monitoring and Warning	Status of Forecasting Model
5 FFWS Basin	Cagayan River Basin	a) The areas along the lower reaches from Tuguegarao to Aparri.	Not operational	Not available
		b) The alluvial plain along the river course from Ilagan to Tumauini, Isabela.	Operational	Not available
	Agno River Basin	a) The entire Pangasinan Plain including the major city/municipalities of Dagupan, Lingayen, Bugallon, Sta. Barbara, Bayambang and Rosales.	Operational	Not available
		b) The central part of Tarlac province including the municipalities of Gerona, Tarlac, Paniqui and Moncada.	Operational	Not available
	Pampanga River Basin	a) The Pampanga River from Arayat to Sulipan	Operational	Not available
		b) Candaba swamp and its surrounding areas	Operational	Not available
		c) The confluence with the Angat River and along Labangan Channel (Hagonoy, Calumpit, Paombong)	Operational	Not available
	Pasig-Laguna De Bay	Mangahan Floodway	Operational	Not available
	Bicol River Basin	a) The Central part of the basin, from Lake Baao to Lake Bato.	RG: Operational WL: Not operational	Not available
		b) The alluvial plain extending around Naga City.	Operational	Not available
		c) The Sipocot river basin downstream from Sipocot.	Not operational	Not available
Remaining 13 Major Basins	Abulug River Basin	Not established	-	-
	Abra River Basin	Not established	-	-
	Panay River Basin	Not established	-	-
	Jalaur River Basin	Not established	-	-
	Ilog-Hilabangan River Basin	Not established	-	-
	Agusan River Basin	Not established	-	-
	Tagoloan River Basin	Not established	-	-
	Cagayan De Oro River Basin	Not established	-	-
	Agus-Lake Lanao River Basin	Not established	-	-
	Davao River Basin	Not established	-	-
	Tagum-Libuganon River Basin	Not established	-	-
	Mindanao (Cotabato) River Basin	Not established	-	-
	Buayan-Malungon River Basin	Not established	-	-
Model Case of Small Basins	Mandulog (Iligan City) River Basin	Not established	-	-

Source: Study Team

Table 6.1.2 Target Areas for FFWSDO in Each River Basin

<table>
<tr><th colspan="2">Name of River Basin</th><th>Main Target Dam</th><th>Target Areas for FFWSDO</th><th>Status of Monitoring and Warning</th><th>Status of Forecasting Model</th></tr>
<tr><td rowspan="6">5 FFWS Basin</td><td>Cagayan River Basin (Cagayan/Magat FFWSDO)</td><td>Magat Dam</td><td>Stretches of the Magat River from NIA Maris Dam to the confluence with the Cagayan River mainstream at Gamu, Isabela</td><td>Partly Operational</td><td>Operational</td></tr>
<tr><td>Agno River Basin (Agno FFWSDO)</td><td>San Roque Dam</td><td>Stretches of the Agno River from NIA ARIS (Agno River Irrigation System) Dam in San Manuel to the confluence with the Tarlac River in Bayambang, Pagasinan</td><td>Operational</td><td>Operational</td></tr>
<tr><td rowspan="2">Pampanga River Basin (Upper Pampanga FFWSDO, Angat FFWSDO)</td><td>Pantabangan Dam</td><td>Stretches of the Upper Pampanga River from NIA Mansiway Dam to Sta. Rosa in Tarlac</td><td>Operational</td><td>Operational but downstream portion is not included</td></tr>
<tr><td>Angat Dam</td><td>Stretches of the Angat River from Padling Warning Station in Norzagaray to the downstream town of Hagonoy, Bulacan</td><td>RG: Partly operational
WL: Not operational</td><td>Operational</td></tr>
<tr><td>Pasig-Laguna De Bay (Caliraya FFWSDO)</td><td>Caliraya Dam</td><td>From Caliraya Dam to Lake Laguna</td><td>RG: Operational
WL: Not operational</td><td>Not available</td></tr>
<tr><td>Bicol River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="13">Remaining 13 Major Basins</td><td>Abulug River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Abra River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Panay River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Jalaur River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Ilog-Hilabangan River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Agusan River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Tagoloan River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Cagayan De Oro River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Agus-Lake Lanao River Basin</td><td>Series of Agus Dams</td><td>-</td><td>Not established</td><td>-</td></tr>
<tr><td>Davao River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Tagum-Libuganon River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Mindanao (Cotabato) River Basin</td><td>Pulanggi Dam</td><td>-</td><td>Not established</td><td>-</td></tr>
<tr><td>Buayan-Malungon River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Model Case of Small Basins</td><td>Mandulog (Iligan City) River Basin</td><td>No target dam</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Source: Study Team

Table 6.4.1 Summary of On-going Projects under PAGASA HMD

No.	Project Title	Study/Pilot Area/Basin	Donor	Project Duration	Focal Point(s)
1	Establishment of FFWS Centers in 13 Major River Basins ("River Centers") Project	12-13 FFWS Centers in 2013	Government of the Philippines (2013 GAA)	2013	Roy A. Badilla, Edgar dela Cruz
2	GMMA Risk Assessment Project (RAP)	GMMA	AusAID/GA	2010-2013	Roy A. Badilla, Adelaida C. Duran
3	Strengthening of Flood Forecasting and Warning System in the Bicol River Basin ("Bicol Project")	Bicol River Basin	Government of Japan (GoJ)	2010-2013	Mario I. Dungca, Jose Perin
4	Strengthening of Flood Forecasting and Warning System on Magat Dam and Downstream Communities ("Norad Project")	Magat Watershed	Norad	2010-2013	Margaret P. Bautista, Berlin Mercado
5	Building Community Resilience and Strengthening Local Government Capacities for Recovery and Disaster Risk Management ("Resilience Project")	GMMA	UNDP/CIDA	2010-2013	Socrates F. Paat Jr., Shiela S. Schneider
6	UNDP Ready for GMMA Project - CBFEWS Component - Flood Hazard Mapping Component - V&A Component	Laguna, Rizal, Cavite & Bulacan, Rizal & Bulacan	UNDP/AusAID	2010-2014 2012-2014 2010-2013 2013-2014	Rosalie S. Pagulayan, Oscar D. Cruz
7	Applying Remote Sensing Technology in River Basin Management in the Philippines	Cagayan River Basin	ADB/JAXA	2013	Socrates F. Paat Jr., Nivagine Nievares
8	Supporting Investsments in Water Related Disaster Management	Cagayan River Basin	ADB/ICHARM	2013	Shiela S. Schneider
9	Ecotown Demonstration Framework on Vulnerability and Adaptation Assessment (V&A) of Vulnerable Areas to Climate Change	Siargao Island, Palawan	GGGI/CCC	2012-2013	Oscar D. Cruz, Leonida Santos
10	Integrating Disaster Risk Reduction and Climate Change Adaptation (DRR/CCA) in Local Development Planning and Decision Making Process	All 13 Regions and 82 Provinces	UNDP/AusAID, NZAP/NEDA	2012-2013	Oscar D. Cruz
11	Enabling the Cities of Cagayan de Oro and Iligan to Cope with Climate Change ("Project Climate Twin Phoenix")	Cagayan de Oro and Mandulog River Basins	UNDP/AusAID	2013-2014	Nivagine C. Nievares
12	Establishment of a Pilot Automatic Warning System (AWS) in Cagayan de Oro River Basin	Cagayan de Oro River Basin	NDMI/MOPAS, Korea	2013	Socrates F. Paat Jr., Berlin Mercado
13	Resilience Capacity Building for Cities and Municipalities to Reduce Disaster Risks from Climate Change and Natural Hazards ("ReBUILD Project")	Regions 2 (CRB), 3 (PRB) and 6 (Jalaur, Aklan, Panay, Ilog-Hilabangan)	UNDP/NZAP	2013-2015	Adelaida C. Duran
14	Counterplan for Extraordinary Flood	Pampanga River Basin	UNESCAP/WMO/ TC/KICT	2012-2014	Nivagine C. Nievares
15	Data Collection on Situation of Nationwide Flood Forecasting and Warning System	All major river basins including Mandulog River basin	JICA	2013	Rosalie S. Pagulayan, Rhonalyn Vergara
16	Operationalization of KOICA2 Project	Pasig-Marikina River Basin	KOICA	2013	Maximo F. Peralta, Shiela S. Schneider
17	Disaster Preparedness and Response Project	Benguet, Cagayan, Laguna, Sorsogon	UN/WFP	2013	Rosalie S. Pagulayan

Source: PAGASA HMD

Table 6.4.2 Target Areas and Components of On-going Projects under PAGASA-HMD and NOAH Project (1/3)

No.		1	2	3	4	5	6
Project Title		River Centers Project	RAP	Bicol Project	Norad Project	Resilience Project	GMMA Ready Project
5 FFWS Basin	Pampanga River Basin						
	Agno River Basin						
	Bicol River Basin			River center ARG (11) AWLG (7) Data transmission system (microwave)			
	Cagayan River Basin				ARG (21) AWLG (10)		
	Pasig-Laguna De Bay		Risk analysis Rainfall-runoff model Inundation model			ARG (22) AWLG (1) CBFEWS Flood drill	CBFEWS Hazard map IEC
Remaining 13 Major Basins	Abra River Basin	River center					
	Abulug River Basin	River center					
	Panay River Basin	River center					
	Jalaur River Basin	River center					
	Ilog-Hilabangan River Basin	River center					
	Agusan River Basin	River center					
	Agus-Lake Lanao River Basin	River center					
	Buayan-Malungon River Basin	River center					
	Cagayan De Oro River Basin	River center					
	Mindanao (Cotabato) River Basin	River center					
	Davao River Basin	River center					
	Tagoloan River Basin	River center					
	Tagum-Libuganon River Basin	River center					
Model Case of Small Basins	Mandulog (Iligan City) River Basin						

Source: PAGASA HMD

Table 6.4.2 Target Areas and Components of On-going Projects under PAGASA-HMD and NOAH Project (2/3)

No.		7	8	9	10	11	12
Project Title		JAXA Project	ICHARM Project	V and A Project	DRR/CCA Project	Project Climate Twin Phoenix	NDMI Project
5 FFWS Basin	Pampanga River Basin		Rainfall-runoff model using IFAS FFWS		Economic projection under CC		
	Agno River Basin				Economic projection under CC		
	Bicol River Basin				Economic projection under CC		
	Cagayan River Basin	Satellite-Based Technology (SBT) Information Communication Technology (ICT)	Rainfall-runoff model using IFAS FFWS		Economic projection under CC		
	Pasig-Laguna De Bay			Hazard map Vulnerability	Economic projection under CC		
Remaining 13 Major Basins	Abra River Basin				Economic projection under CC		
	Abulug River Basin				Economic projection under CC		
	Panay River Basin				Economic projection under CC		
	Jalaur River Basin				Economic projection under CC		
	Ilog-Hilabangan River Basin				Economic projection under CC		
	Agusan River Basin				Economic projection under CC		
	Agus-Lake Lanao River Basin				Economic projection under CC		
	Buayan-Malungon River Basin				Economic projection under CC		
	Cagayan De Oro River Basin				Economic projection under CC	ARG AWLG	Automated Warning
	Mindanao (Cotabato) River Basin				Economic projection under CC		
	Davao River Basin				Economic projection under CC		
	Tagoloan River Basin				Economic projection under CC		
	Tagum-Libuganon River Basin				Economic projection under CC		
Model Case of Small Basins	Mandulog (Iligan City) River Basin				Economic projection under CC	ARG AWLG	

Source: PAGASA HMD

Table 6.4.2 Target Areas and Components of On-going Projects under PAGASA-HMD and NOAH Project (3/3)

No.		13	14	15	16	17	18
Project Title		ReBUILD Project	KICT Project	Nationwide FFWS	KOICA 2	WFP Project	NOAH Project
5 FFWS Basin	Pampanga River Basin		Hazard map	Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Agno River Basin			Data collection survey		Use of Vetiver Grass to prevent soil erosion and landslides	ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Bicol River Basin			Data collection survey		Construction of evacuation centers (near Bicol river basin)	ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Cagayan River Basin			Data collection survey		Construction of storage facility	ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Pasig-Laguna De Bay			Data collection survey		AWS Flood Drill FEWS Solid waste management Capacity building	ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
Remaining 13 Major Basins	Abra River Basin			Data collection survey			
	Abulug River Basin			Data collection survey			
	Panay River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Jalaur River Basin	Hazard/ Risk map Vulnerability assessment CB-EWS		Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Ilog-Hilabangan River Basin	Hazard/ Risk map Vulnerability assessment CB-EWS		Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Agusan River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Agus-Lake Lanao River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Buayan-Malungon River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Cagayan De Oro River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Mindanao (Cotabato) River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Davao River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Tagoloan River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
	Tagum-Libuganon River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC
Model Case of Small Basins	Mandulog (Iligan City) River Basin			Data collection survey			ARG,AWLG Flood Hazard Maps Flood Forecasting IEC

Source: PAGASA HMD

Table 7.4.1 Available Flood Runoff Models in Target River Basins

Name of River Basin		Model Name	Project	Calibration		Note
				Target Flood	Target Location	
5 FFWS Basin	Cagayan River Basin	IFAS	ICHARM	December 2011	(No Information)	
		Storage Function Method	JICA TCP	TY Emong, 2009	Magat dam	Magat Dam Basin Model
	Agno River Basin	Storage Function Method	JICA TCP	TY Marce, 2004. TY Pepeng, 2009	Ambuklao dam, Binga dam, San Roque dam	Upstream Model
		(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
	Pampanga River Basin	Storage Function Method	JICA TCP	TY Pedring, 2011	Pantabangan dam, Sapang Buho WL station	Upper Pampanga River Basin Model
		Storage Function Method	JICA TCP	TY Ondoy and Pepeng, 2009. TY Pedring, 2011	Angat dam, Bustos dam	Angat River Basin Model
		IFAS	ICHARM	(No Information)	(No Information)	
		(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
	Pasig-Laguna De Bay	HEC-HMS, RAS	RAP	(No Information)	(No Information)	
		HEC-HMS, RAS	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
	Bicol River Basin	(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
Remaining 13 Major Basins	Abulug River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Abra River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Panay River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Jalaur River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Ilog-Hilabangan River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Agusan River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Tagoloan River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Cagayan De Oro River Basin	(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
	Agus-Lake Lanao River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Davao River Basin	(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	
	Tagum-Libuganon River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Mindanao (Cotabato) River	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
	Buayan-Malungon River Basin	(Not Available)	(Not Available)	(Not Available)	(Not Available)	
Model Case of Small Basins	Mandulog (Iligan City) River Basin	(To be developed)	NOAH Project (UP Flood NET Project)	(No Information)	(No Information)	

Note: The status is as of March 2013.
Source: Study Team

Table 7.5.1 Available Inundation Analysis Oupputs in Target River Basins

River Basin	READY Project		MGB		JICA FRIMP		Project NOAH		DFO		JICA FFWSDO	
Cagayan	A		A		A				A		-	
Agno	-		A		A	(U)			A		-	
Pampanga	A		A		A	(U)			A		A	(D)
Pasig-Laguna	A		A		A	(U)	A	(PM)	A	(D)	-	
Bicol	-		-		A				A		-	
Abulog	-		A		A				A		-	
Abra	A		A		A				A		-	
Panay	-		A		A						-	
Jalaur	-		A		A						-	
Ilog-Hilabangan	-		A		A						-	
Agusan	-		A		A	(U)			A		-	
Tagoloan	-		A		A						-	
Cagayan De Oro	-		A		A		A				-	
Agus	-		A		A						-	
Tagum-Libuganon	-		-		A						-	
Davao	-		-		A						-	
Mindanao (Cotabato)	-		A		A				A		-	
Buayan-Malungon	-		-		A						-	
Mandulog (Iligan)	-		A		A		A				-	

Source: Ready Project, MGB, JICA FRIMP, Project NOAH, DFO, and JICA FFWSDO

Legend: (A) - map is available

(-) - map is not available

(U) - available only in the upstream area

(D) - available only in the downstream area

(PM) - available only in the Pasig-Marikina area

Table 9.3.1 Methods of Communications for the River Basins in Agno and Pampanga

River Basin	Sender	Recipient	Means of Communications			
			FAX/TEL PLDT	FAX/TL VOIP	SMS	Internet Web
Agno/Pampanga	PAGASA/ HMD	FFWS Sub-Center	✓	✓	✓	✓
		Dam Office	✓	✓	✓	✓
		OCD-NDRRMC	✓	✓	✓	✓
		PDRRMC	✓		✓	✓
		NPC/NIA	✓	✓	✓	✓
		TV, Media	✓		✓	✓

Source: Study Team

Table 9.3.2 Methods of Communications for the River Basin in Pasig-Laguna de Bay

River Basin	Sender	Recipient	Means of Communications			
			FAX/TEL PLDT	FAX/TL VOIP	SMS	Internet Web
Pasig-Laguna de Bay	MMDA Rosario Office	PGASA/ HMD	✓	✓		
		OCD-NDRRMC	✓			
		PDRRMC	✓			
		LGU's	✓			

Source: Study Team

Table 9.3.3 Methods of Communications for the River Basins in Bicol and Cagayan

River Basin	Sender	Recipient	Means of Communications			
			FAX/TEL PLDT	FAX/TL VOIP	SMS	Internet Web
Cagayan/Bicol	Sub-Center	PAGASA/ HMD	✓		✓	✓
		PRSD	✓		✓	✓
		Local TV Media	✓		✓	✓
		PDRRMC	✓		✓	✓
	PGASA/HMD	OCD-NDR RMC	✓	✓	✓	✓

Source: Study Team

Table 9.3.4 Methods of Communications for the River Basins without FFWS

River Basin	Sender	Recipient	Means of Communications			
			FAX/TEL PLDT	FAX/TL VOIP	SMS	Internet Web
Abra	PAGASA/ HMD	PRSD Northern Luzon	✓		✓	✓
Abulog		OCD-NDR RMC	✓	✓	✓	✓
Panay	PAGASA/ HMD	PRSD Visayas	✓		✓	✓
Jalaur						
IIog-Hilabangan		OCD-NDR RMC	✓	✓	✓	✓
Agusan	PAGASA/ HMD	PRSD Mindanao	✓		✓	✓
Agus-Lake Lanao						
Buayan-Malungo n						
Cagayan de Oro						
Mindanao		OCD-NDR RMC	✓	✓	✓	✓
Davao						
Tagoloan						
Tagum-Libugano n						
Mandulog						

Source: Study Team

Table 11.4.1 Identified Issues of Non-Telemetered River Basin
(Initial Stage: Planning, Design, Procurement and Installation)

Case Study- Agusan River Basin

(shaded) :Main Tasks

No.	Required Roles	Role Demarcation: HMD – FFWS	HMD – HMDAS	HMD – HMTS	PRSD – River Center[1]	ETSD[2]	Out-sourcing (Consultant/ Contractor)	Other Projects	Current Assessment (Provisional)	Future Development Needs
1	Data/Information Collection (rainfall, water level, river profile, cross sections, flood damage, inundation maps, LIDAR data, etc.)				-			None	-In order to conduct subsequent work items, required data/information shall be collected through field reconnaissance and from agencies concerned.	-
2	Field Investigation (site survey, topographic survey, river cross section survey, propagation test etc.)				-			None	-Experiences/ knowledge of preparation of topographic survey and soil mechanical investigation is required.	- Training of respective element of field survey and investigation
3	Hydrological Analysis (correlation of water levels, rainfall- runoff analysis, hydraulic analysis, flood inundation analysis, etc .)				-			None	-Experiences/ knowledge of hydrological/hydraulic analyses to determine the flood warning water levels is required.	-Application of IFAS for flood runoff analysis will be one option. -Overall training of applied hydrology with focusing FFWS
4	System Planning (meteohydrological aspect)				-			None	-Experiences/ knowledge on the study of hydrological monitoring network is required.	- Training for preparation of flood runoff models and inundation analysis models
5	System Planning (data sharing/telecommunication aspect)				-			None	-Experiences/ knowledge on the design of data transmission and telecommunication system is required.	-Training/practices of design works of telecommunication system
6	Basic design including preliminary cost estimate				-			None	-Experiences/ knowledge of preliminary design and cost estimate is required.	-Training for design works for simple civil structures and telecommunication facilities
7	Detailed Design (civil works & telecom. works)				-			None	-Experiences/ knowledge of structural design and design criteria of associated civil works (river bank protection works, etc.) is required.	Not applicable
8	Preparation of Bid Documents/Drawings				-			None	-Experiences/ knowledge of preparation of bid documents including the General/ Technical Specifications is required.	Not applicable
9	Prequalification/Bidding, Evaluation and Contracting				-		BAC will be in charge.	None	-Experiences/ knowledge of evaluation of bids and preparation of evaluation criteria is required.	Not applicable
10	Construction and installation works				-			PAGASA River Center Project	-Experiences/ knowledge of construction management is required.	Not applicable

O & M Stage

Remarks: (shaded) Roles demarcated **(in ideal system)**

(1, Assumed not yet established at this stage.

(2, Engineering and Technical Services Division

Source: Study Team

Overall Comments:

(1) There is no on-going project by donor(s) in the Agusan River basin.

(2) Capacity development of ETSD will be separate issue.

(3) In accordance with the progress of the River Center (at Prosperidad), role demarcation shall be elaborated.

(4) Security problem shall be carefully considered from planning stage of the system.

Table 11.4.2 Idendified Issues of Telemetered River Basin (1/2)

Case Study-Cagayan River Basin

:Main Tasks

	Main Category	PAGASA HMD			PRSD	Out-sourcing	Other Major Projects	Current Assessment (provisional)	Achievement (in recent 5 years)	Future Development Needs
		FFWS	HMDAS	HMTS	River Center					
1.	Basin/River system monitoring						JICA, NORAD	-Accuracy of forecasting basin rainfall shall be improved. -Overwrapping of JICA FFWS and NOAH's WL.	Dam Discharge Warning Manual and Flood Warning Manual were updated by JICA TCP.	-Effective use of synoptic and NOAH's monitoring stations (with development of management rules of monitoring stations)
2.	Data collection for flood forecasting						JICA TCP	-Telemetered rainfall and water level data cannot be shared in real time among Tuguegarao Sub-center, PAGASA WFFC and NIA Magat Dam Office. -Rainfall data of the Radar at Aparri cannot be received at Tuguegarao		-Utilization of rainfall data from Doppler radars -Weather Forecaster shall be assigned at Tuguegarao Sub-center.
3.	Database management						JICA TCP	-Monitored data need to be properly stored and shared with other agencies.	-Hydrological database of PAGASA and NIA G/S were created.	-Integration of database system -Skill for updating of the database contents -Data transferring system to concerned agencies
4.	Discharge measurement						JICA TCP	-Continuous conducting of field measurement is very important.	-H~Q curved were updated at Aurora Bridge in the Magat River.	-Periodical review and update of H~Q Curves
5.	Assessment and update of Flood Warning Water Levels						JICA TCP	-Flood Warning Water Levels at Aurora Bridge were established and managed currently.	-Established flood warning water levels at Aurora Bridge (Base Point).	-Review the WL stations in same manner at other key WL stations (recommended by former JICA TCP).
6.	Flood forecasting						- JICA TCP - ADB-ICHARM (IFAS)	-Newly developed flood runoff model (by JICA TCP) is useful for flood forecasting in the Magat River basin. -IFAS training will be further needed.		-Expansion/ updating of existing flood runoff model to cover whole catchment -Elaboration of IFAS -Development of inundation analysis model
7.	Issuance of flood information						JICA TCP	-Rapid and timely sharing of flood information from Tuguegarao Sub-center need to be improved. -Coverage of the flood information in the basin is insufficient.		-Development of more reliable means for rapid transmission of flood information -Increase of monitoring stations (in scarce river basins)
8.	Post-flood investigation							- To enhance manner of routine works to record and analyze major flood events		-To encourage close coordination in PAGASA HMD with flexible assignment of the staff.
9.	Public Information and Education Drives					NGOs		-To continue PAGASA's program by own fund	-Consultation to LGUs and other stakeholders prior to the flood drills.	-Coordination with OCD R2 and LGUs shall be strengthened.
10.	Telemetry and Telecommunication						JICA Grant & TCP, NORAD	-Telecom. staff shall be allocated at Tuguegarao Sub-center to strengthen maintenance works of the equipment. -Telecom. lines between Tuguegarao Sub-center, PAGASA WFFC and Magat Dam Office are disconnected.	-Water level sensor was installed at reservoir of Managt Dam and Maris Dam.	-Development of standards for procurement of FFWS equipment is necessary. -Reliable telecommunication systems shall be established. -Telecommunications for information
11.	Flood drills	–					JICA TCP	-Coordination with NIA Magat Dam office and LGUs shall be enhanced.	-Conducted twice at Magat Dam	(Activities has just started from 2013 in conformity with recommendation of the former JICA TCP)

Source: Study Team

Note: FFWS: Flood Forecasting and Warning Section, HMDAS: Hydro meteorological Data Application Section, HMTS: Hydrological Telemetry Section, PRSD: PAGASA Regional Services Division

Table 11.4.2 Identified Issues of Telemetered River Basin (2/2)

Case Study - Pasig-Laguna de Bay River

: Main tasks

	Main Category	PAGASA HMD			Out-sourcing	Other Major Projects	Current Assessment (Provisional)	Achievement (in recent 5 years)	Future Development Needs
		FFWS	HMDAS	HMTS					
1.	Basin/River system monitoring					UNDP Ready, KOICA, RAP, Resilience Project	-Overwrapping of WL gauges of EFCOS, KOICA and NOAH at Sto. Nino G/S		-Effective use of synoptic and NOAH's monitoring stations (with development of management rules of monitoring stations)
2.	Data collection for flood forecasting					JICA	-Data indication on the monitor of NOAH shall be further improved (demarcation between "no rain" and "missing data", etc.) -Handling of data in different system during flood occurrence will become crucial for appropriate issuance of flood information.		-Indication of monitors needs to be improved.
3.	Database management								-Integration of database system -Skill for updating of the database contents -Data transferring system to concerned agencies
4.	Discharge measurement					JICA	-To encourage as routine works		-Periodical review and update of H~Q Curves
5.	Assessment and update of Flood Warning Water Levels					JICA	-Flood warning water levels at same location set by EFCOS and KOICA are different. Unified WLs shall be applied through substantial review.		-Review the WL stations in same manner (recommended by former JICA TCP) -Change/ update of flood warning water levels on PC monitors shall be enabled by HMD staff.
6.	Flood forecasting						-Reliability of NOAH's flood runoff model shall be assessed for FFW purposes.	Flood hazard maps were prepared by the Project NOAH and Resilience Project.	-Expansion/ updating of existing flood runoff models -Development of IFAS -Development of inundation analysis model
7.	Issuance of flood information						-Clear demarcation of responsibility between PAGASA and MMDA for issuance of flood information and warning shall be examined and fixed. -Flood information issued by MMDA (or PAGASA) shall be examined together with development of the integrated data		-Data/information sharing system among agencies shall be re-established. -Development of more reliable means for rapid transmission of flood information -Operation Manual for utilization of EFCOS and KOICA is necessary.
8.	Post-flood investigation						- To enhance manner of routine works to record and analyze major flood events		-To encourage close coordination in PAGASA HMD with flexible assignment of the staff.
9.	Public Information and Education Drives				NGOs		-To continue PAGASA's program by own fund		-Coordination with OCD, MMDA and LGUs shall be strengthened.
10.	Telemetry and Telecommunication					JICA (EFCOS), KOICA, NOAH, Resilience Project, etc.	-Maintenance of NOAH's stations is inadequate (ex. stolen rain gauge at Napindan G/S)	-To be installed 13 rain gauges and 28 water level gauges under the Resilience Project.	-Integration of NOAH's stations under PAGASA HMD with shifting ASTI's function including human resources to PAGASA (if required).
11.	Flood drills						-PAGASA HMD jointly conducted drills with MMDA under Resilience Project.	-Conducted under the Resilience Project in March 2013	-To repeat and encourage to conduct the drills by similar manners which were applied in JICA TCP

Source: Study Team

Note: FFWS: Flood Forecasting and Warning Section, HMDAS: Hydrometeorological Data Application Section, HMTS: Hydrological Telemetry Section, PRSD: PAGASA Regional Services Division

Table 11.5.1 List of Priority Plan A (Target: Level 1)

Major Components	Contents/Activities	Application of Japanese Technology for Enhancement	Note	Applicable River Basin: Jalaur	Agusan*	Tagoloan	Cagayan de Oro	Davao	Tagum-Libuganon*	Mindanao	Buayan-Malungon	Time Frame
1. Strengthening of meteorological and hydrological monitoring	(1) Setting of FFWS target areas			○	○	○	○	○	○	○	○	2014 ~ 2015
	(2) Methodology for selection of appropriate monitoring locations and type of monitoring devices			○	-	○	○	○	○	-	○	
	(3) Evaluation on appropriateness of existing locations of rainfall and water level gauging stations to cover important areas for FFWS			○	-	○	○	○	○	-	○	
	(4) Methodology for planning of system configuration of telemetry system to connect GS with river centers			○	-	○	○	○	○	-	○	
	(5) Particular conditions for regional security (difficulty for installation of gauging stations)	IFAS/GSMaP technology	Assuming in Agusan and Mindanao River	-	○	-	-	-	-	○	-	
2. Strengthening of data management/security system at PAGASA Weather and Flood Forecasting Center (WFFC)	(1) Determination of kinds of data (hourly rainfall, hourly water level, reservoir water level, etc.) to be handled and coverage of system	ICT will be applied .	The data from existing FFWS in 5 river basins will be the target for establishment of data management system in WFFC. Therefore, this component is an option for formulation of the Project.	-	-	-	-	-	-	-	-	2014~ 2016
	(2) Overall system design of hardware (main frame, storage, back-up system, etc.) and software with security system			-	-	-	-	-	-	-	-	
	(3) Standardization of data type, format and other protocol including integration of existing system (EFCOS, KOICA, etc.)			-	-	-	-	-	-	-	-	
	(4) Automatic sharing system to transfer data/information to other agencies concerned			-	-	-	-	-	-	-	-	
	(5) Rule of periodical maintenance and technical services for the system to be procured			-	-	-	-	-	-	-	-	
3. Establishment of effective data accumulation, sharing and transferring system at river centers	(1) Establishment of data storage and simple database system at river center			○	○	○	○	○	○	○	○	2015 ~ 2016
	(2) Development of information sharing network with LGUs concerned (PDRRMCs and OCD Regional Office, etc.)			○	○	○	○	○	○	○	○	
4. Setting warning standards and contents of flood information to disseminate to LDRRMCs	(1) Development of flood warning water levels and trigger level of rainfall amount at key gauging stations.			○	○	○	○	○	○	○	○	2014 ~ 2016
	(2) Preparation of flood operation manual for river centers with standard forms for flood information/bulletins			○	○	○	○	○	○	○	○	
	(3) IEC activities to strengthen LDRRMCs in collaboration with OCD Regional Offices			○	○	○	○	○	○	○	○	
5. Inter-agencies' institutional strengthening	(1) Establishment of communication network for sharing flood information and issuance of flood warning			○	○	○	○	○	○	○	○	2014 ~ 2015
	(2) Integration of NOAH's staff into HMD for strengthening of O & M for NOAH's stations			○	○	○	○	○	○	○	○	
	(3) Conduct of flood drills and stakeholder consultation with LDRRMCs concerned			○	○	○	○	○	○	○	○	
6. Equipment planning and O &M	(1) Installation of minimum number of rainfall and water level gauges for flood monitoring		Security issues shall be considered.	○	○	○	○	○	○	○	○	2015 ~ 2016
	(2) Preparation of standard technical specification/ bidding documents for procurement of FFWS equipment	Technical standards/ specifications/ guidelines issued by MLIT in Japan		○	○	○	○	○	○	○	○	
	(3) Development of O & M rules and manuals for NOAH's stations			○	○	○	○	○	○	○	○	
7. Particular technical training course/ issues	(1) IFAS/ satellite technology training			-	○	-	-	-	-	○	-	2014 ~ 2016
	(2) Basic training of applied hydrology (hydraulic analysis, frequency analysis of rainfall/runoff, etc.)			○	○	○	○	○	○	○	○	
	(3) Pathloss training			○	○	○	○	○	○	○	○	
	(4) AutoCAD training			○	○	○	○	○	○	○	○	
	(5) GIS training			○	○	○	○	○	○	○	○	
	(6) Survey training (conventional method, ADCP & LIDAR, etc.)			○	○	○	○	○	○	○	○	
	(7) ICT training for database management			○	○	○	○	○	○	○	○	
	(8) ICT training for telecommunication			○	○	○	○	○	○	○	○	
	(9) Remote sensing training			○	○	○	○	○	○	○	○	
8. Upgrade planning of the FFWS to Level-2	(1) Preliminary study for upgrading to Level-2 &3 (including advanced data transferring system from Mindanao to PAGASA WFFC, Q.C.)			○	○	○	○	○	○	○	○	2016
	(2) Preparation of a strategic plan for further application of advanced technology in Japan	Terrestrial Digital TV, disaster information multi-delivery system, and CCTV, etc.	Securing of versatile means of dissemination will be the key concept.	○	○	○	○	○	○	○	○	

Source: Study Team   Note:*, Co-finance for construction and operation of the river centers is currently offered by LGUs to PAGASA. Detailed demarcation among the agencies needs

Legend: [shaded green] Explained in Chapter 10

Table 11.5.2 List of Priority Plan B (Target: Level 3)

Major Components	Contents/Activities	Application of Japanese Technology for Enhancement	Note	Applicable River Basin					Time Frame
				Cagayan	Agno	Pampanga	Pasig-Marikina	Bicol	
1. Strengthening of meteorological and hydrological monitoring	(1) Evaluation on appropriateness of existing locations of rainfall and water level gauging stations to expand the areas for FFWS		Effective use of synoptic and NOAH's monitoring stations	○	○	○	○	○	2014 ~ 2016
	(2) Utilization of rainfall data from Doppler radars for flood forecasting	Correction of radar rainfall estimate by means of the records at ARGs	Close coordination with "The Project for Strengthening of Forecasting and Warning Capability"(1 is required.	○	○	○	○	○	
	(3) Installation of additional Doppler radars	X-Band MP radar system		-	-	-	○	-	
	(4) Classification of gauging station considering of durability and accuracy, etc.		Certain rules and principles shall be established.	○	○	○	○	○	
2. Strengthening of data management/security system at PAGASA Weather and Flood Forecasting Center (WFFC)	(1) Determination of kinds of data (hourly rainfall, hourly water level, reservoir water level, etc.) to be handled and coverage of system	ICT will be applied .		○	○	○	○	○	2014~ 2016
	(2) Overall system design of hardware (main frame, storage, back-up system, etc.) and software with security system			○	○	○	○	○	
	(3) Standardization of data type, format and other protocol including integration of existing system (EFCOS, KOICA, etc.)			○	○	○	○	○	
	(4) Automatic sharing system to transfer data/information to other agencies concerned			○	○	○	○	○	
	(5) Rule of periodical maintenance and technical services for the system to be procured			○	○	○	○	○	
3. Establishment of effective data accumulation, sharing and transferring system at river centers	(1) Establishment of data storage system with integration of individual projects such as EFCOS, KOICA, NOAH, UNDP/AusAID is required.			-	-	-	○	-	2014 ~ 2016
	(2) Establishment data sharing/ transferring system between river centers and PAGASA WFFC, Q.C.			○	-	-	-	-	
	(3) Re-establishment of flood information transferring system from PAGASA to the central government agencies and LGUs concerned	Disaster information multi-delivery system		○	○	○	○	○	
	(4) Development of flood runoff models and expansion of existing flood runoff models			○	○	○	○	○	
	(5) Development of inundation analysis model			○	○	-	○	○	
4. Setting warning standards and contents of flood information to disseminate to LDRRMCs	(1) Re-setting and/or revision of flood warning water levels at key gauging stations.			○	○	○	○	○	2014 ~ 2016
	(2) Preparation of flood operation manual for river centers with standard forms for flood information/bulletins			-	-	-	○	○	
	(3) IEC activities to strengthen LDRRMCs in collaboration with OCD Regional Offices			○	○	○	○	○	
5. Inter-agencies' institutional strengthening	(1) Integration of NOAH's staff into HMD for strengthening of O & M for NOAH's stations			-	-	-	○	○	2014 ~ 2015
	(2) Conduct of flood drills and stakeholder consultation with LDRRMCs concerned			○	○	○	○	○	
	(3) Re-organizing and strengthening of River Centers			○	○	○	○	○	
6. Equipment planning and O &M	(1) Installation of additional rainfall and water level gauging stations with telemetry system to be connected with river center (for Level 3 system)	IP network technology	Security issues shall be considered.	○	○	○	○	○	2015 ~ 2016
	(2) Preparation of standard technical specification/ bidding documents for procurement of FFWS equipment	Technical standards/ specifications/ guidelines issued by MLIT in Japan	Existing network provided by other projects, NOAH and PAGASA himself shall be duly evaluated.	○	○	○	○	○	
	(3) Development of O & M rules and manuals for NOAH's stations			○	○	○	○	○	
7. Particular technical training course/ issues	(1) Training of applied hydrology (hydraulic analysis, frequency analysis of rainfall/runoff, etc.)			○	○	○	○	○	2014 ~ 2016
	(2) Pathloss training			○	○	○	○	○	
	(3) AutoCAD training			○	○	○	○	○	
	(4) GIS training			○	○	○	○	○	
	(5) Survey training (conventional method, ADCP & LIDAR, etc.)			○	○	○	○	○	
	(6) ICT training for database management			○	○	○	○	○	
	(7) ICT training for telecommunication			○	○	○	○	○	
	(8) Remote sensing training			○	○	○	○	○	

Source: Study Team Note: (1, Scheduled to start in 2013 Legend: [green box] Explained in Chapter 10

Table 11.5.3 List of Priority Plan C (Target: Level 2 & 3)

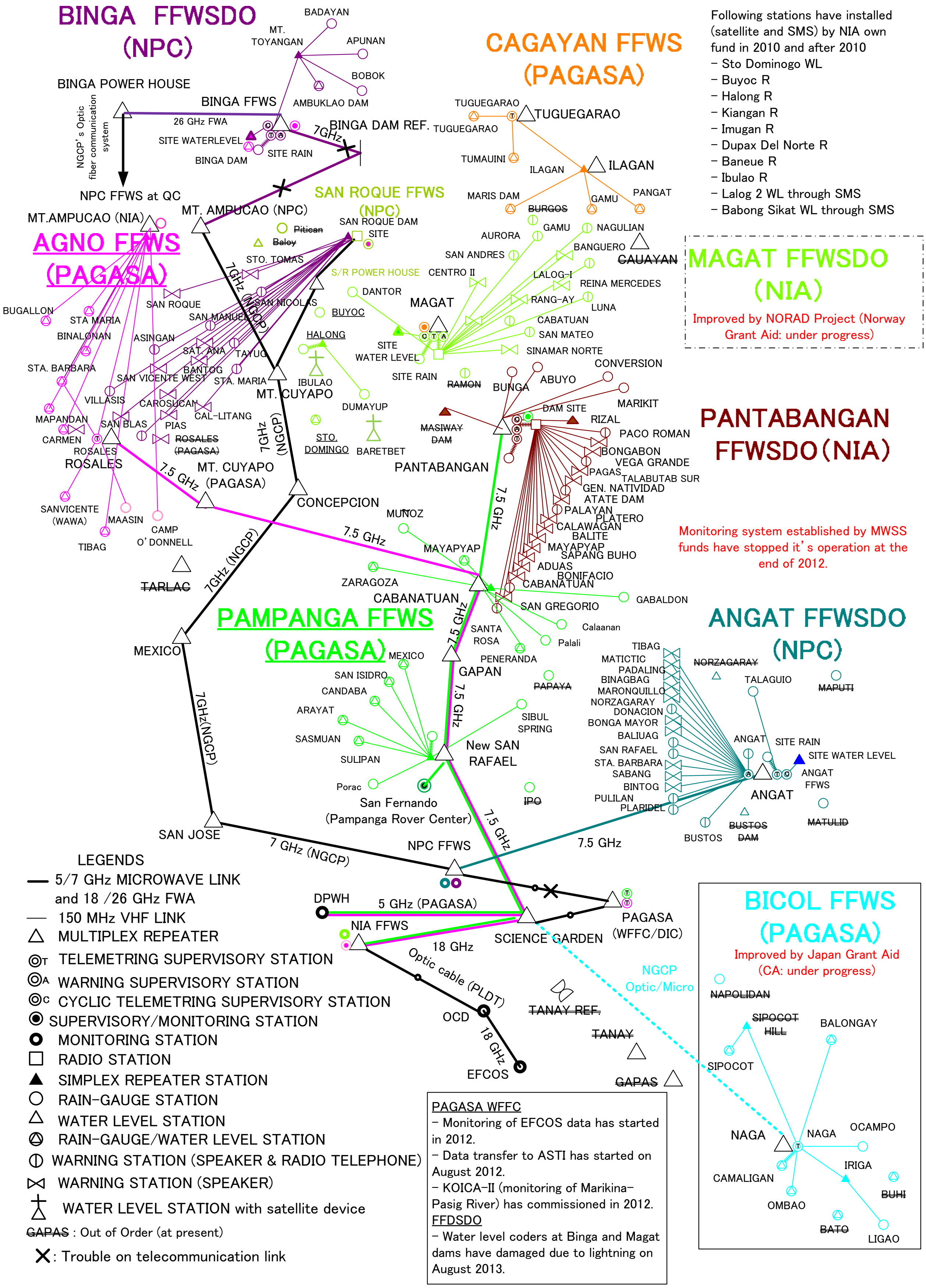
Major Components	Contents/Activities	Application of Japanese Technology for Enhancement	Note	Applicable River Basin								Time Frame
				Jalaur	Agusan	Tagoloan	Cagayan de Oro	Davao	Tagum-Libuganon	Mindanao	Bauyan-Malungon	
1. Strengthening of meteorological and hydrological monitoring	(1) Evaluation on appropriateness of existing locations of rainfall and water level gauging stations to expand the areas for FFWS		Effective use of synoptic and NOAH's monitoring stations	○	○	○	○	○	○	○	○	2017 ~ 2018
	(2) Utilization of rainfall data from Doppler radars for flood forecasting		Need of calibration by Climate TCP	○	○	○	○	○	○	○	○	
	(3) Installation of additional Doppler radars in urban areas	X-Band MP radar system	Necessity will mainly depend on the demand of urban drainage.	-	-	-	-	○	-	-	-	
	(3) Classification of gauging station considering of durability and accuracy, etc.		Rules and principles shall be established.	○	○	○	○	○	○	○	○	
2. Strengthening of data management/security system at PAGASA Weather and Flood Forecasting Center (WFFC)	(1) Determination of kinds of data (hourly rainfall, hourly water level, reservoir water level, etc.) to be handled and coverage of system	ICT will be applied .		○	○	○	○	○	○	○	○	2017~ 2019
	(2) Overall system design of hardware (main frame, storage, back-up system, etc.) and software with security system			○	○	○	○	○	○	○	○	
	(3) Standardization of data type, format and other protocol			○	○	○	○	○	○	○	○	
	(4) Automatic sharing system to transfer data/information to other agencies concerned			○	○	○	○	○	○	○	○	
	(5) Rule of periodical maintenance and technical services for the system to be procured			○	○	○	○	○	○	○	○	
3. Establishment of effective data accumulation, sharing and transferring system at river centers	(1) Establishment of data storage system with integration of individual projects			○	○	○	○	○	○	○	○	2018 ~ 2019
	(2) Establishment data sharing/ transferring system between river centers and PAGASA WFFC, Q.C.			○	○	○	○	○	○	○	○	
	(3) Re-establishment of flood information transferring system from PAGASA to the central government agencies and LGUs concerned	Disaster information multi-delivery system		○	○	○	○	○	○	○	○	
	(4) Development of flood runoff models and expansion of existing flood runoff models			○	○	○	○	○	○	○	○	
	(5) Development of inundation analysis model			○	○	○	-	○	○	○	○	
4. Setting warning standards and contents of flood information to disseminate to LDRRMCs	(1) Re-setting and/or revision of flood warning water levels at key gauging stations.			○	○	○	○	○	○	○	○	2017 ~2019
	(2) Preparation of flood operation manual for river centers with standard forms for flood information/bulletins			-	-	-	-	-	○	○	○	
	(3) IEC activities to strengthen LDRRMCs in collaboration with OCD Regional Offices			○	○	○	○	○	○	○	○	
5. Inter-agencies' institutional strengthening	(1) Integration of NOAH's staff into HMD for strengthening of O & M for NOAH's stations			-	-	-	-	-	○	○	○	2017 ~ 2018
	(2) Conduct of flood drills and stakeholder consultation with LDRRMCs concerned			○	○	○	○	○	○	○	○	
	(3) Re-organizing and strengthening of River Centers			○	○	○	○	○	○	○	○	
6. Equipment planning and O &M	(1) Installation of additional rainfall and water level gauging stations with telemetry system to be connected with river center (for Level 3 system)	IP network technology	Security issues shall be considered.	○	○	○	○	○	○	○	○	2018 ~ 2019
	(2) Preparation of standard technical specification/ bidding documents for procurement of FFWS equipment	Technical standards/ specifications/ guidelines issued by MLIT in Japan	Existing network provided by other projects, NOAH and PAGASA himself shall be duly evaluated.	○	○	○	○	○	○	○	○	
	(3) Development of O & M rules and manuals for NOAH's stations			○	○	○	○	○	○	○	○	
7. Particular technical training course/ issues	(1) Training of applied hydrology			○	○	○	○	○	○	○	○	2017 ~ 2019
	(2) Pathloss training			○	○	○	○	○	○	○	○	
	(3) AutoCAD training			○	○	○	○	○	○	○	○	
	(4) GIS training			○	○	○	○	○	○	○	○	
	(5) Survey training (conventional method, ADCP & LIDAR, etc.)			○	○	○	○	○	○	○	○	
	(6) ICT training for database management			○	○	○	○	○	○	○	○	
	(7) ICT training for telecommunication			○	○	○	○	○	○	○	○	
	(8) Remote sensing training			○	○	○	○	○	○	○	○	

Source: Study Team

Note:*, Co-finance for construction and operation of the river center is currently offered by LGUs to PAGASA. Detailed demarcation among the agencies needs to be clarified. The state of accomplishment of Project A will be assessed in the planning stage.

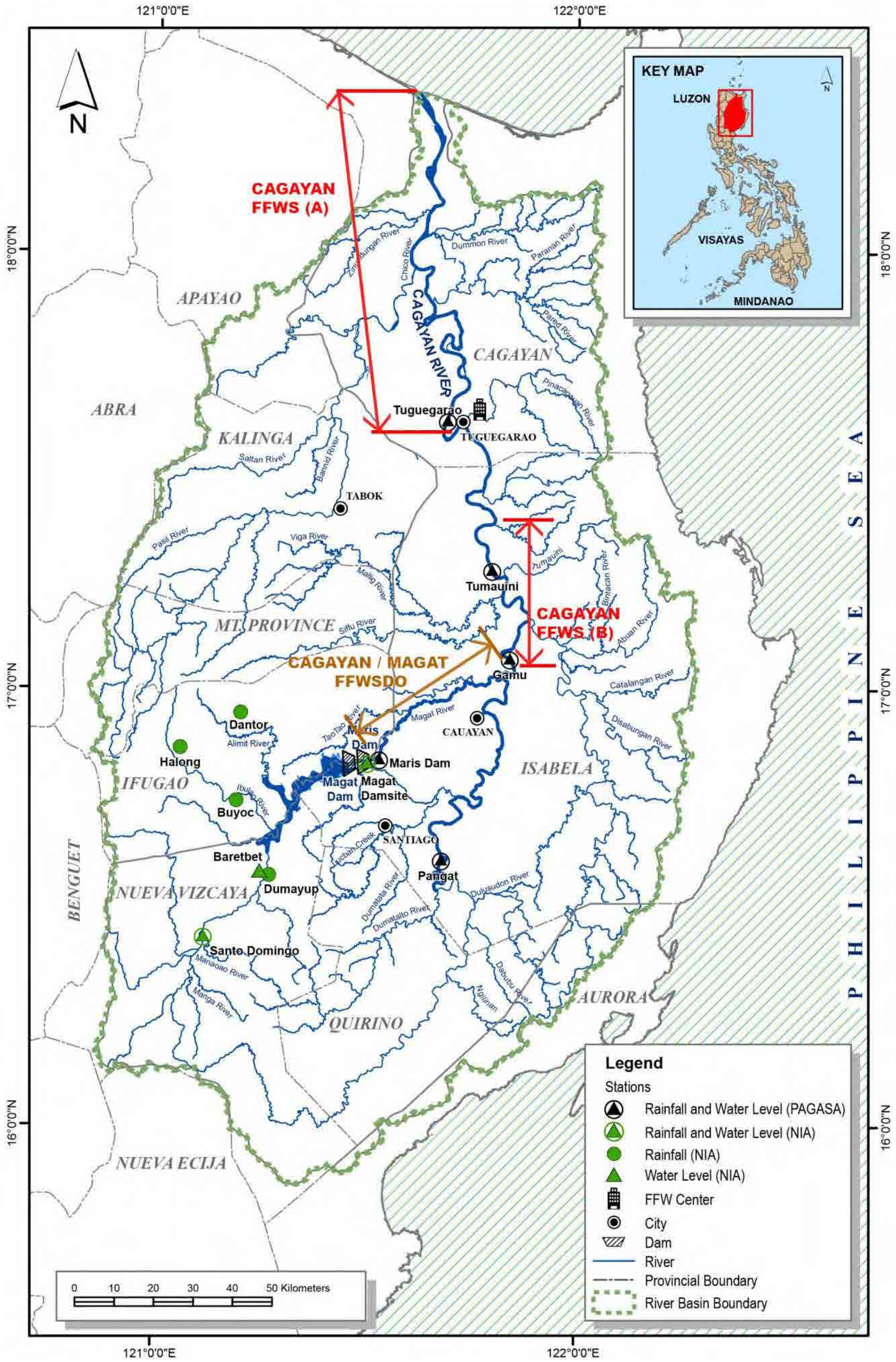
Legend: (shaded) Explained in Chapter 10

Figures



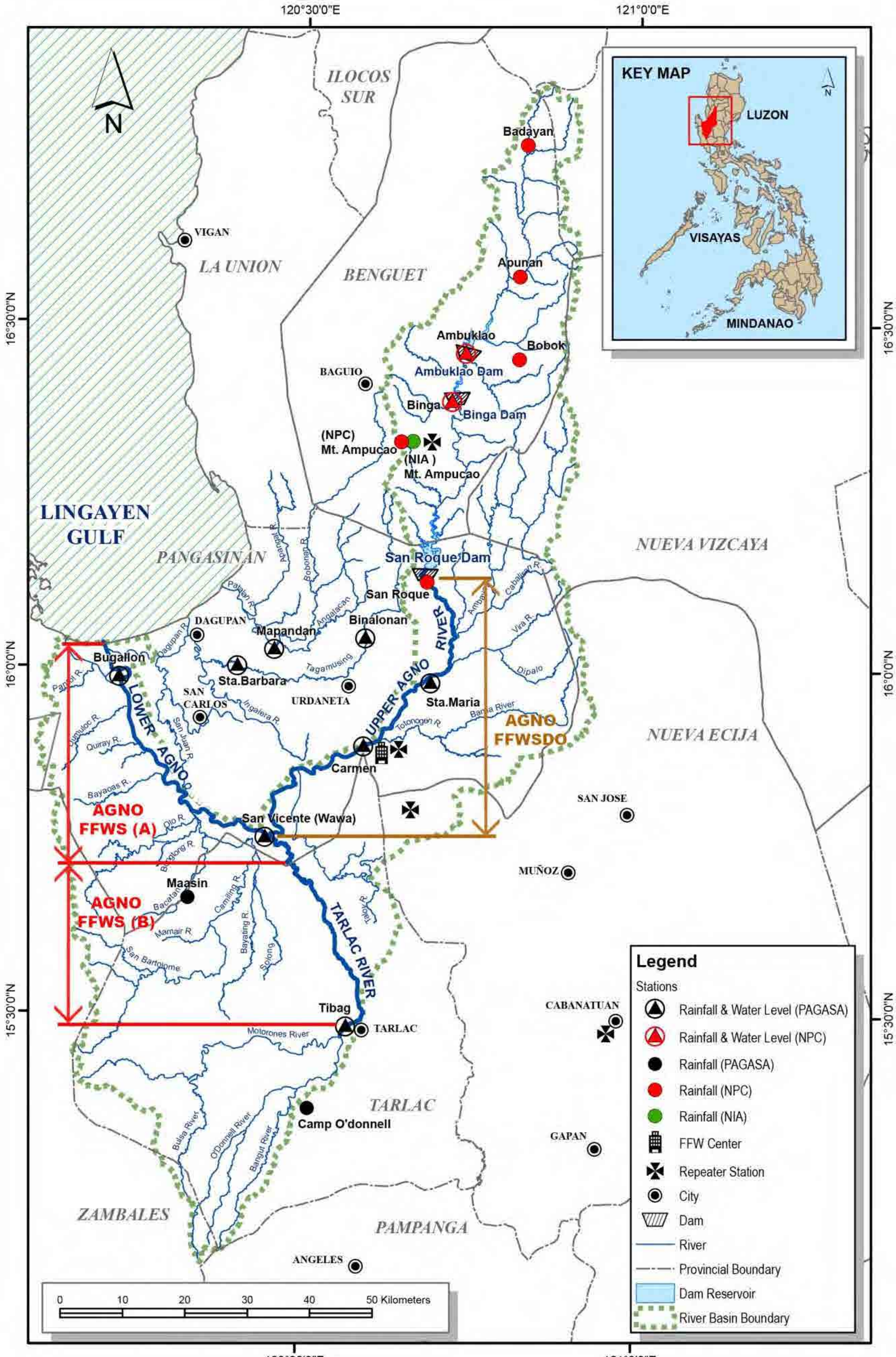
Source: Study Team

Figure 6.1.1 Existing FFWS / FFWSDO



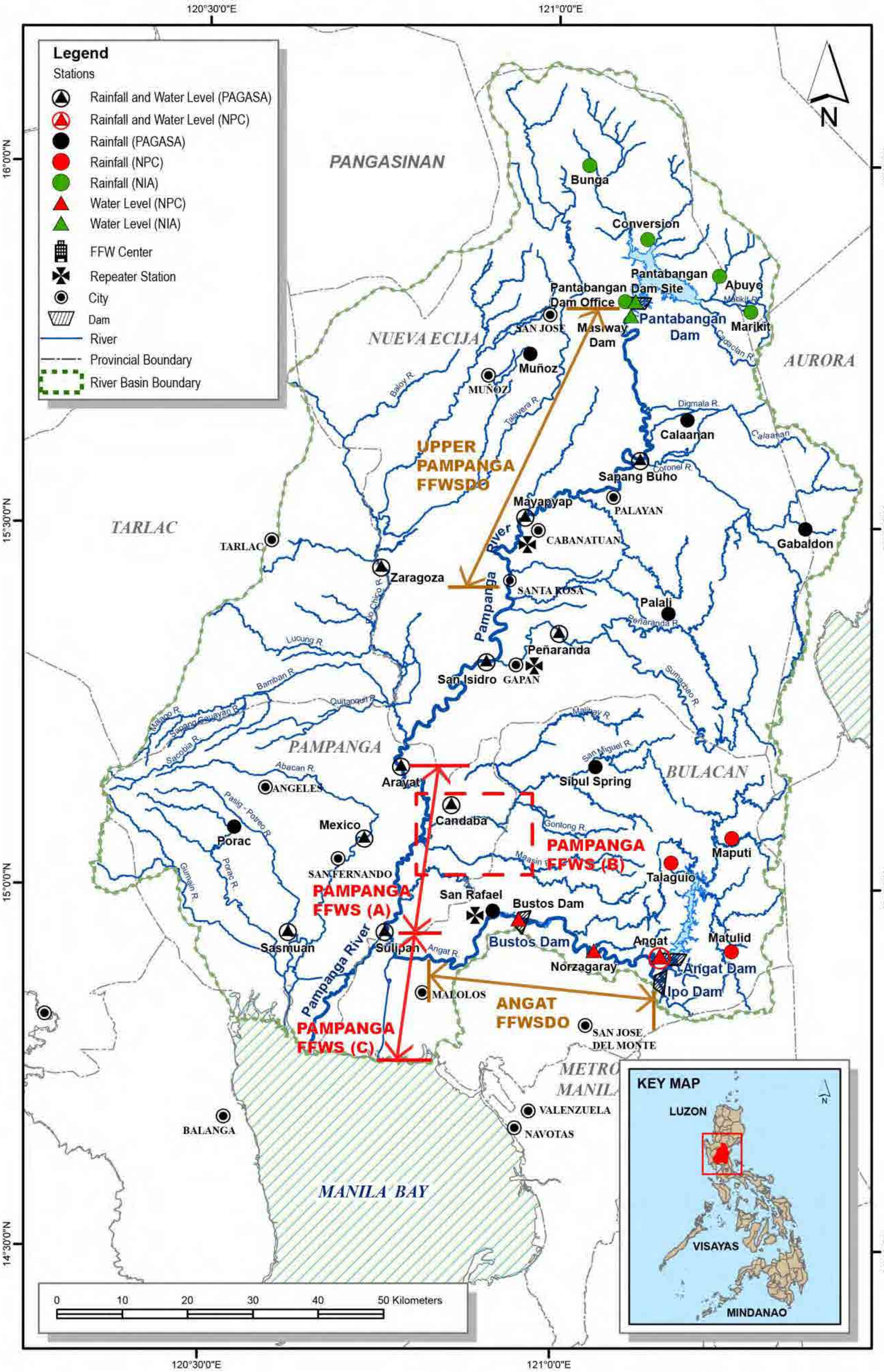
Source: Study Team

Figure 6.1.2 Target Areas of Existing FFWS/FFWSDO (1/5)



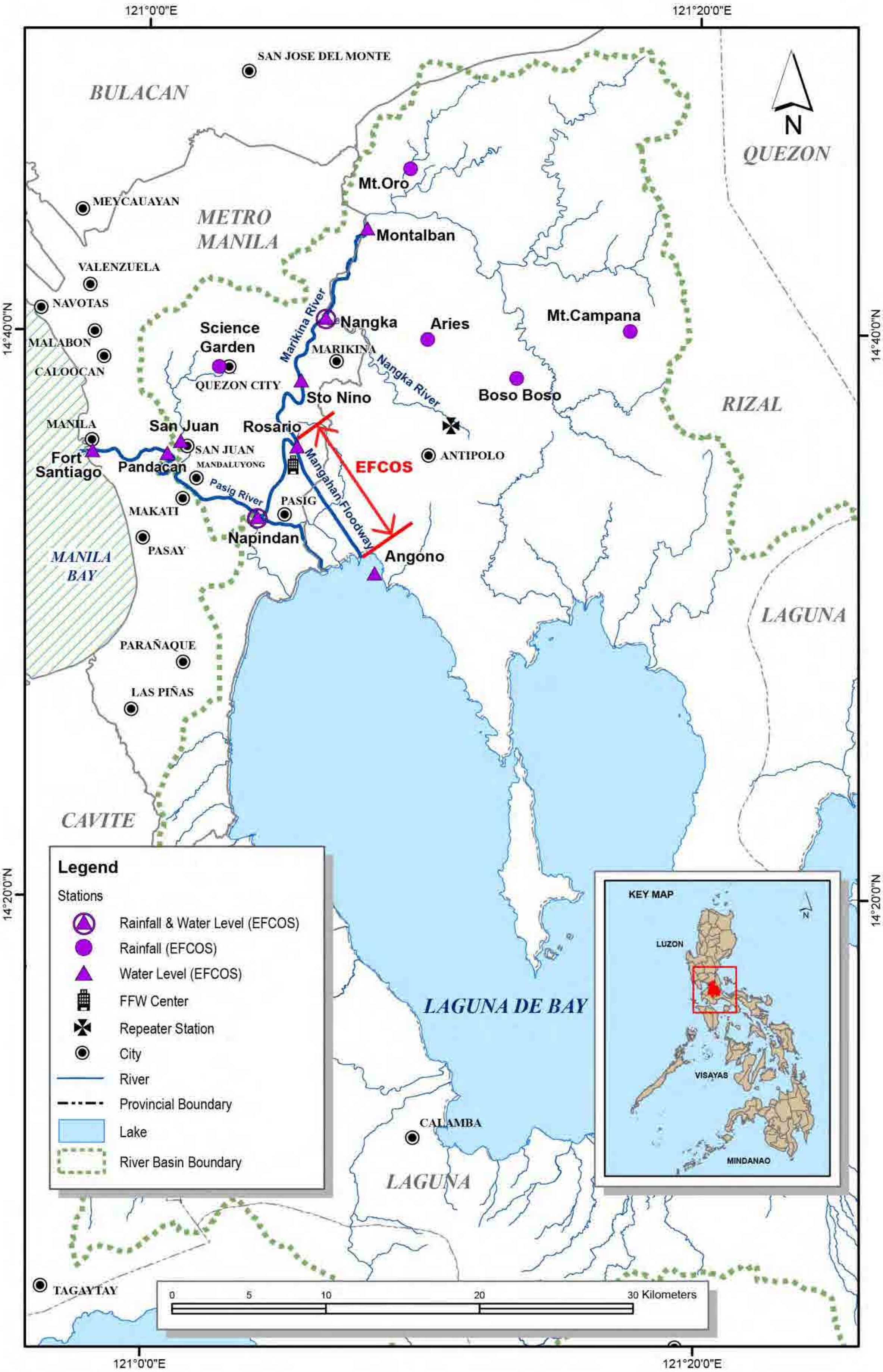
Source: Study Team

Figure 6.1.2 Target Areas of Existing FFWS/FFWSDO (2/5)



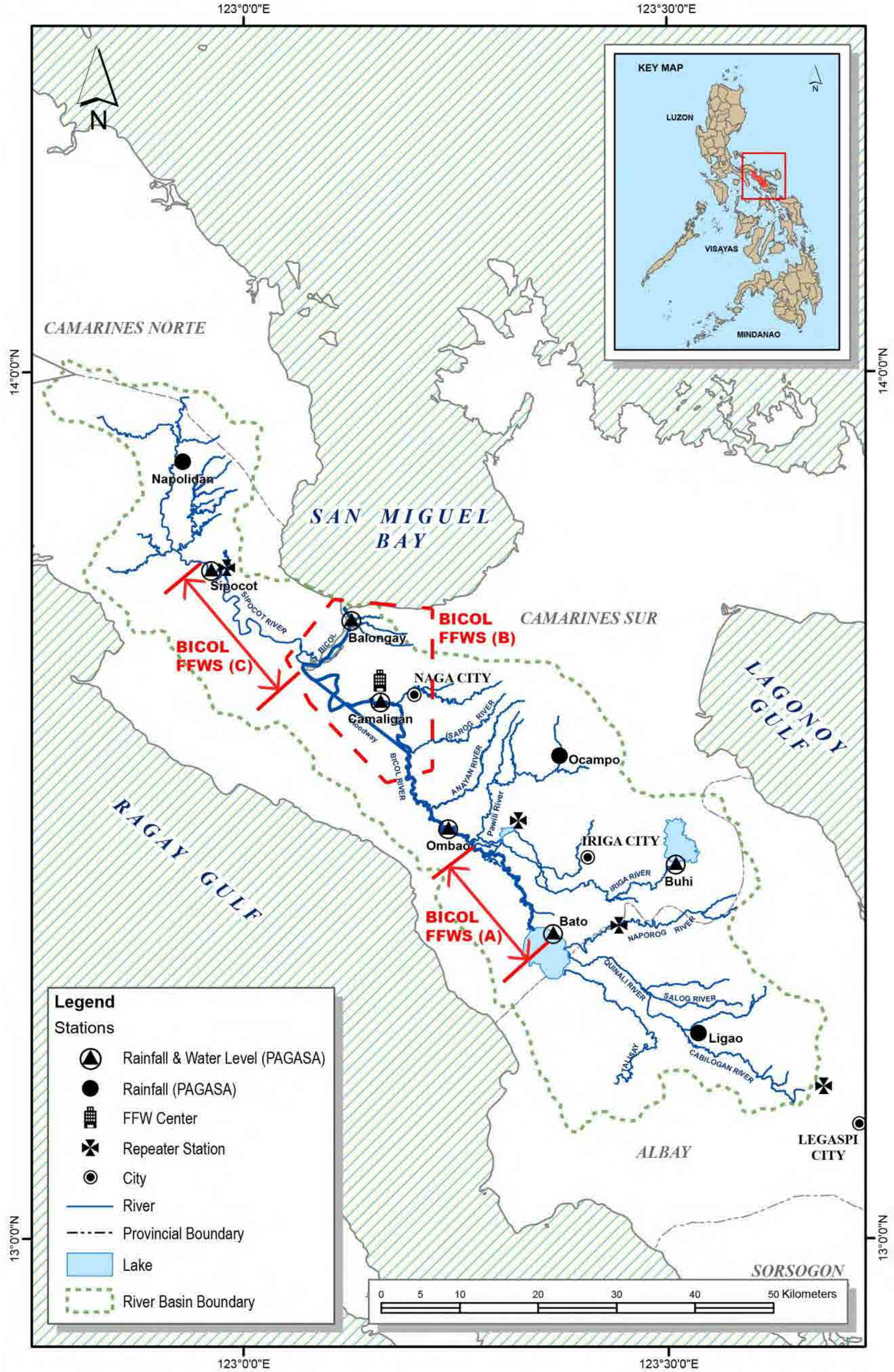
Source: Study Team

Figure 6.1.2 Target Areas of Existing FFWS/FFWSDO (3/5)



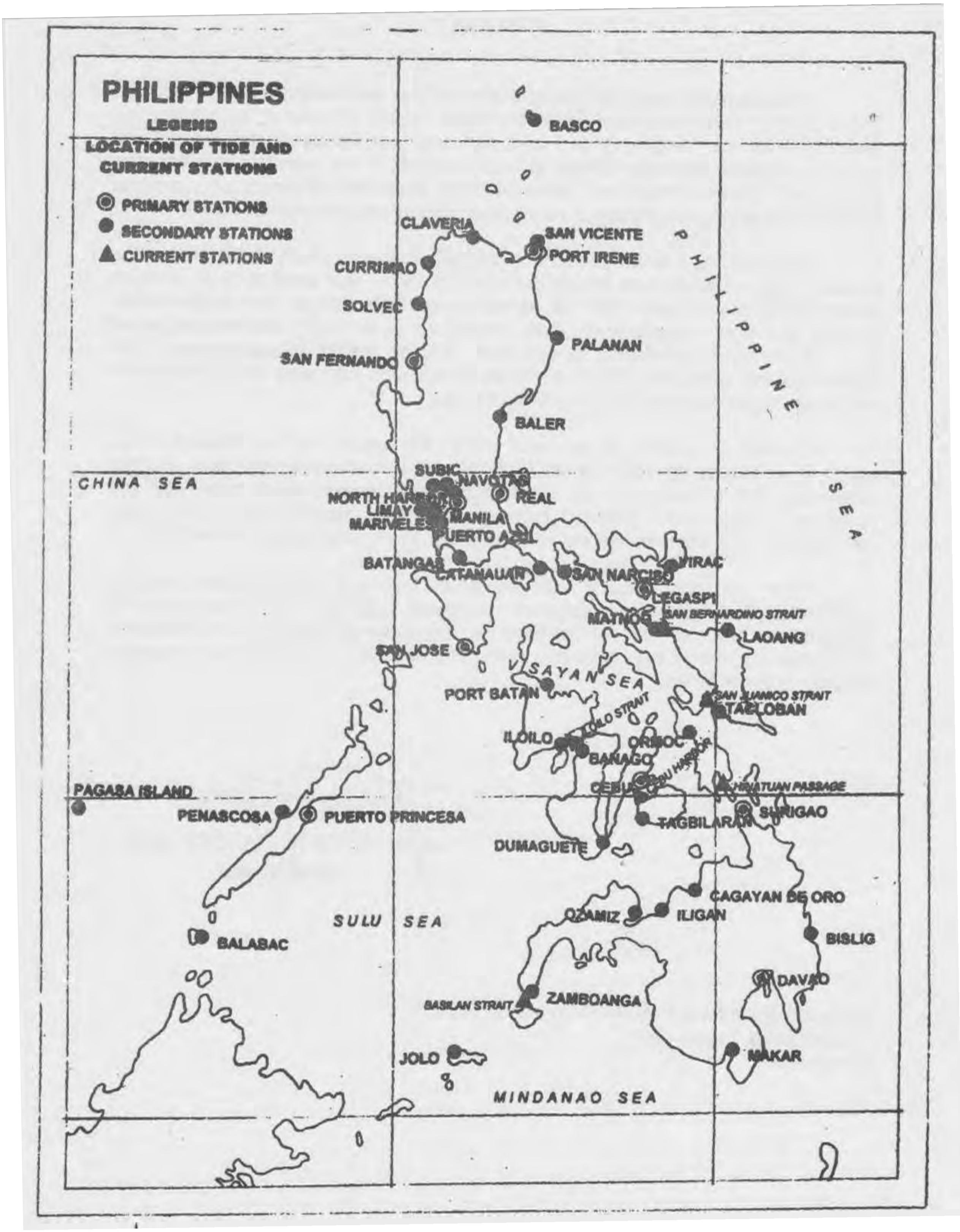
Source: Study Team

Figure 6.1.2 Target Areas of Existing FFWS/FFWSDO (4/5)



Source: Study Team

Figure 6.1.2 Target Areas of Existing FFWS/FFWSDO (5/5)



Source: NAMRIA

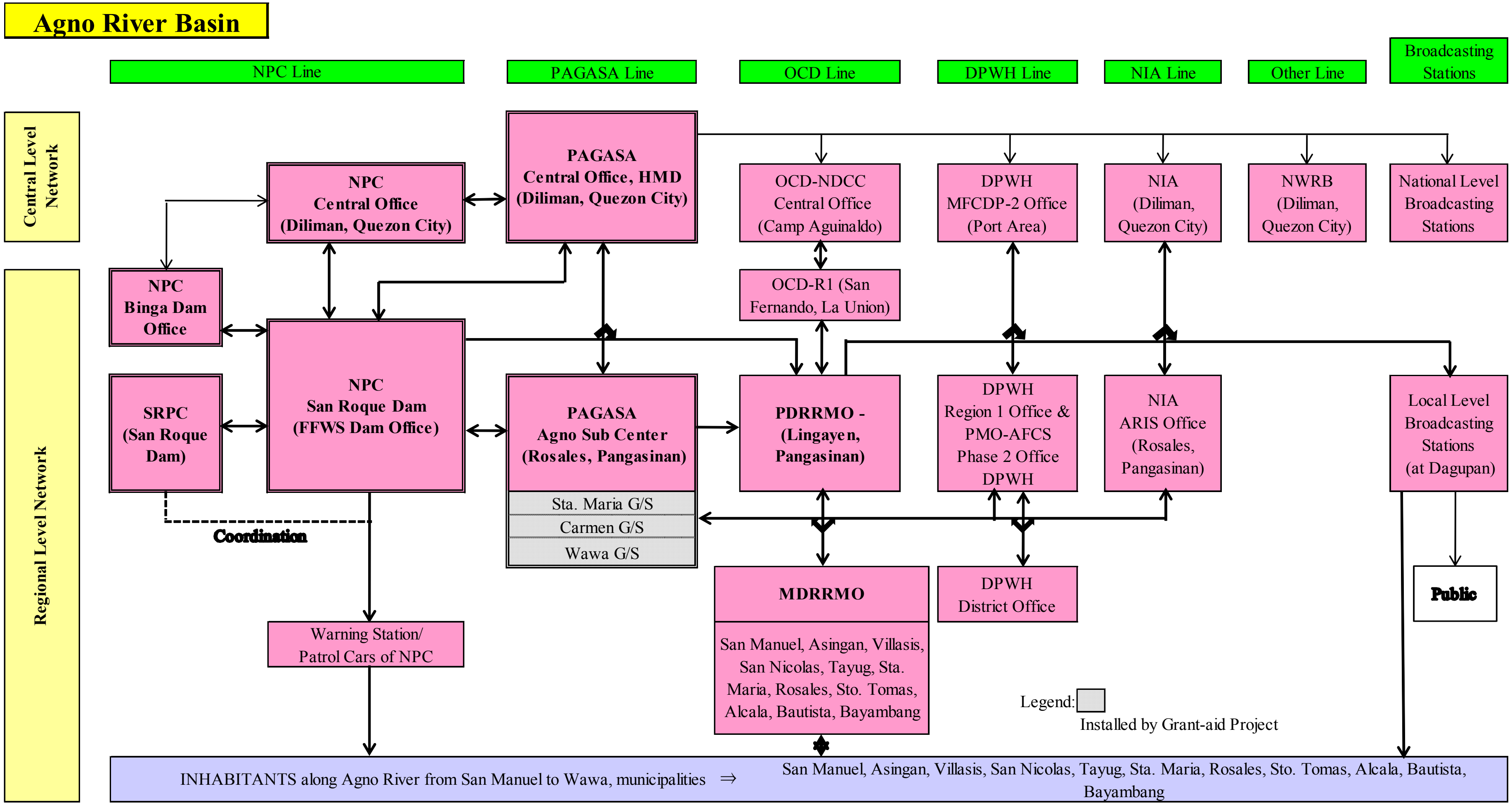
Figure 7.1.1 Location of NAMRIA Tide Stations

	
Synoptic Station Rain Gauge (Tipping Bucket Rain Gauge)	Synoptic Station Rain Gauge (Standard Manual Rain Gauge)
	
NOAH AWS[1] (ASTI)	ASTI ARG[2]
	
PAGASA AWS (KOICA-I)[3]	EFCOS Rain Gauge[4]

Source: Study Team

Figure 7.1.2 Rainfall Gauges at PAGASA Science Garden

[1] The observed data can be seen on the Project NOAH website. The data is also transferred to the PAGASA ARG website, which is secured with password.
[2] -ditto-
[3] The study team conducted the interview survey to the Science Garden Complex Station, PAGASA. The observation data during heavy rainfall events is not reliable due to low height of the instruments. There is a need to elevate the instrument. The observed data can be seen on the PAGASA AWS website, which is secured with password. This rain gauge is named as DPAWS in PAGASA METTSS/ETSD.
[4] The observed data is not sent to the Rosario Master Control station due to the problem of the telemeter system.

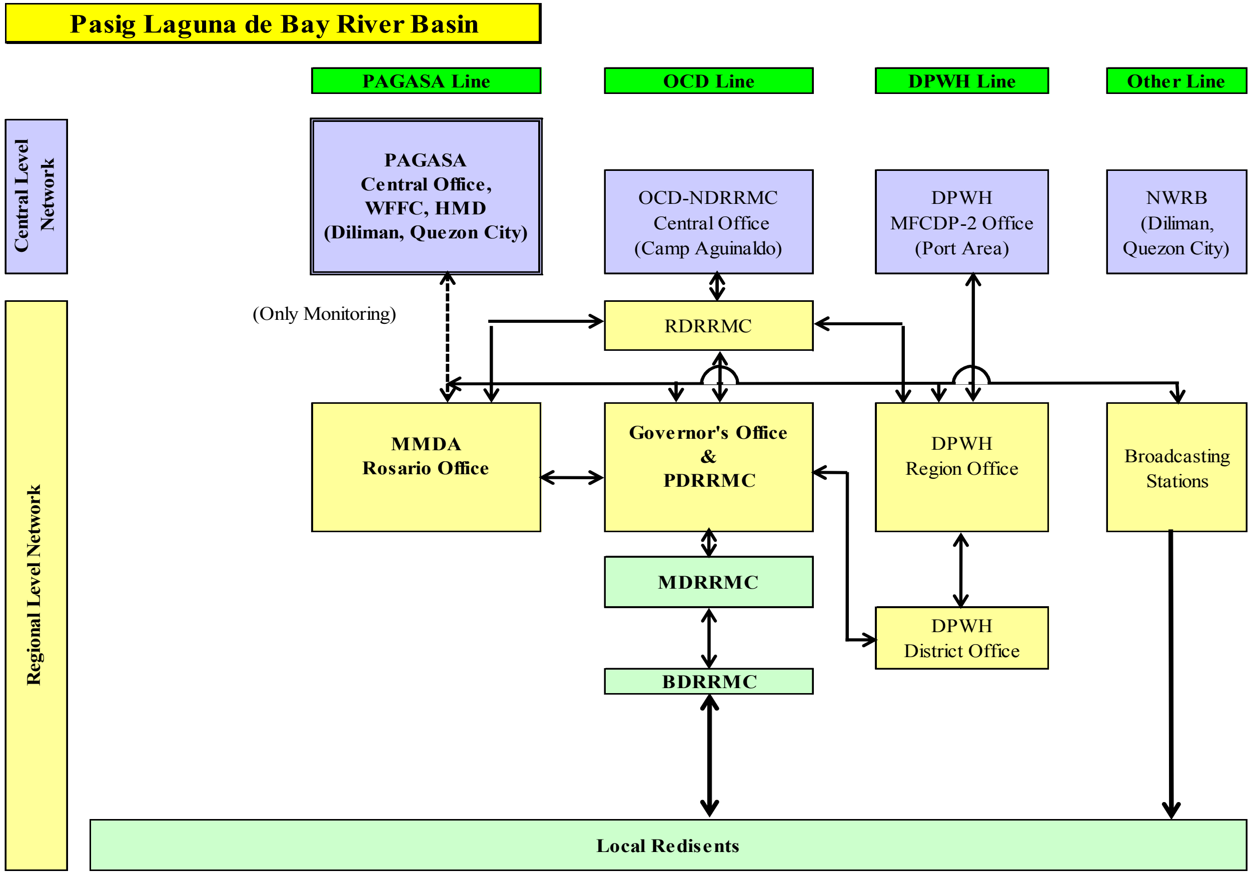


Note: The above chart was drafted with integration of the recommended plan by LGUs which has been presented in the Workshop on July 15, 2010.

Dam Discharge Warning:
Warning 1 - Before commencement of discharge
Warning 2 - After commencement of discharge
Warning 3 - Rapid increase of discharge

Source: Operation Manual of Dam Flow and Dam Downstream Forecasting Model for the Angat River Basin

Figure 9.3.1 Dam Discharge Warning Information Network in Agno River Basin

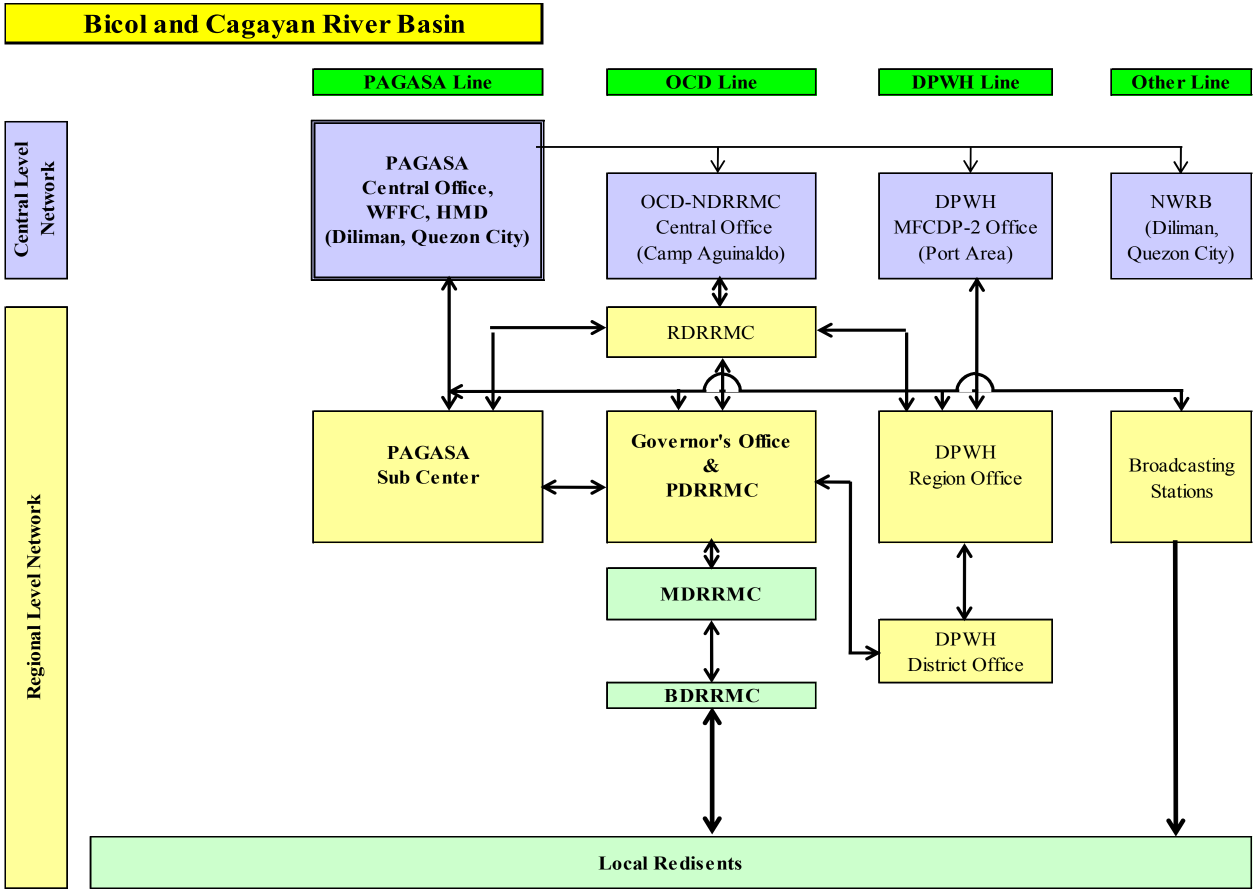


Note:

WFC, Weather and Flood Forecasting Center
HMD, Hydrometeorological Division
MMDA, Metro Manila Development Authority
RDRRMC, Regional Disaster Risk Reduction Management Committee
PDRRMC, Provintial Disaster Risk Reduction Management Committee
MDRRMC, Municipal Disaster Risk Reduction Management Committee
BDRRMC, Barangay Diaster Risk Reduction Management Committee

Source: Study Team

Figure 9.3.2 Flood Warning Information Network in Pasig Laguna de Bay River Basin

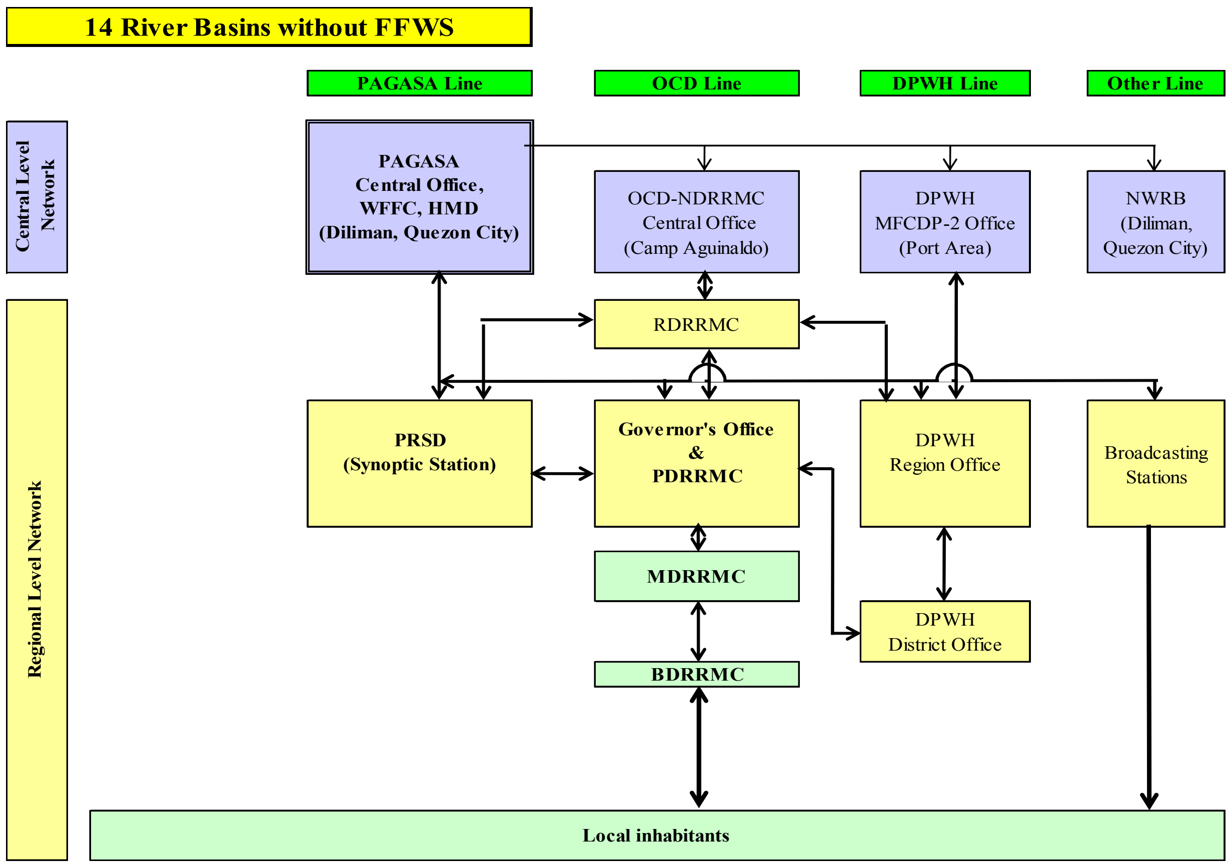


Note:

WFC, Weather and Flood Forecasting Center
HMD, Hydrometeorological Division
DPWH, Dpartment of Public Works and Highways
PDRRMC, Provintial Disaster Risk Reduction Management Committee
MDRRMC, Municipal Disaster Risk Reduction Management Committee
BDRRMC, Barangay Diaster Risk Reduction Management Committee

Source: Study Team

Figure 9.3.3 Flood Warning Information Network in Bical and Cagayan River Basin



Note:

WFC, Weather and Flood Forecasting Center
HMD, Hydrometeorological Division
DPWH, Department of Public Works and Highways
PDRRMC, Provintial Disaster Risk Reduction Management Committee
MDRRMC, Municipal Disaster Risk Reduction Management Committee
BDRRMC, Barangay Diaster Risk Reduction Management Committee
PRSD, PAGASA Regional Services Division

Source: Study Team

Figure 9.3.4 Flood Warning Information Network in River Basin without FFWS