モザンビーク共和国
公共事業住宅水資源省

モザンビーク国
水関連災害リスク管理
組織能力強化支援

業務完了報告書

平成 30 年 4 月
(2018 年)

独立行政法人
国際協力機構（JICA）

いであ株式会社

環境
JR
18-039

主要 13 河川の流域面積

River	国内の流域	全流域	
Rovuma R.	101,160 km^2	155,400 km^2	(国際河川)
Messalo R.	24,000 km^2	24,000 km^2	
Lurio R.	60,800 km^2	60,800 km^2	
Ligonha R.	16,299 km^2	16,299 km^2	
Licungo R.	27,726 km^2	27,726 km^2	
Zambeze R.	140,000 km^2	1,200,000 km^2	(国際河川)
Pungwe R.	28,000 km^2	29,500 km^2	(国際河川)
Buzi R.	25,600 km^2	28,800 km^2	(国際河川)
Save R.	4,550 km^2	88,395 km^2	(国際河川)
Limpopo R.	79,620 km^2	412,000 km^2	(国際河川)
Incomati R.	14,925 km^2	46,246 km^2	(国際河川)
Umbeluzi R.	2,356 km^2	5,600 km^2	(国際河川)
Maputo R.	1,570 km^2	29,800 km^2	(国際河川)

主要 13 河川の流域図

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略語表

略語	英語	日本語
ANE	National Road Administration, MOPHRH	公共事業住宅水資源省 道路公社
ARA	Regional Water Authority, MOPHRH	公共事業住宅水資源省 地域水管理事務所
ARA-N	Northern Regional Water Authority, MOPHRH	北部地域水管理事務所
ARA-CN	North-Central Regional Water Authority	中北部地域水管理事務所
ARA-C	Central Regional Water Authority, MOPHRH	中部地域水管理事務所
ARA-SUL	Southern Regional Water Authority, MOPHRH	南部地域水管理事務所
CENOE	National Center of Emergency Operation	国家緊急対応センター
C/P	Counterpart	カウンターパート
DAS	Department of Water & Sanitation DNA	上下水道局
DEM	Digital Elevation Model	数値標高モデル
DGBH	Department of River Basins Management	河川流域管理部
DNGRH	National Directorate of Water Resources Management	公共事業住宅水資源省 水資源管理局
DNAPOT	Directorate of Land Use Planning	土地利用計画局
DNHU	Directorate of Housing and Urbanization	国家住宅都市局
DP	Department of Planning, DNGRH	公共事業住宅水資源省 計画部
DPA	Provincial Department of Agriculture	州農業部
DPOPHRH	Provincial Department of Public Works, Housing and Water Resources	州公共事業住宅水資源部
DRI	Department of International Rivers	国際河川部
EM-DAT	Emergency Events Database	緊急事態データベース
FIPAG	Water Supply Investment & Asset Holding Company	水供給投資基金
GIS	Geographic Information System	地理情報システム
GPS	Global Positioning System	全地球測位システム
GSMaP	Global Satellite Mapping of Precipitation	衛星全球合成降水マップ
HFA	Hyogo Framework for Action	兵庫鼓動枠組
ICHARM	International Centre for Water Hazard and Risk Management under the auspices of UNESCO	国際水災害リスクマネジメントセンター
IFAS	Integrated Flood Analysis System developed by ICHARM	統合洪水解析システム
IFM	Integrated Flood Management	統合洪水管理
INAM	National Institute of Meteorology	国家気象院
INGC	National Institute of Disaster Management, MAE	国家災害管理院
iRIC	International River Interface Cooperative	国際河川インターフェース研究
IWRM	Integrated Water Resources Management	統合水資源管理
JICA	Japan International Cooperation Agency	国際協力機構
MICOA	Ministry of the Coordination of Environmental Affairs	環境活動調整省
MINAG	Ministry of Agriculture	農業省
MOPHRH	Ministry of Public Works, Housing and Water Resources	公共事業住宅水資源省
MPD	Ministry of Planning and Development	企画開発省
OJT	On the job training	オンザジョブトレーニング
PCM	Project Cycle Management	プロジェクト・サイクル・マネジメン

		ト
UNISDR	United Nations International Strategy for Disaster Reduction	国連国際防災戦略
USGS	United States Geological Survey	アメリカ地質調査所
WCDRR	World Conference on Disaster Risk Reduction	国連防災世界会議

第１章　業務の概要

1.1　業務の背景

近年、モザンビーク共和国（以下、「モザンビーク」と記す）では経済成長を目指した開発投資が活発化する一方で、気候変動や国内及び周辺国の開発によって引き起こされる自然災害によるリスクが増大し被害は拡大している。具体的には、洪水、サイクロン、海岸浸食、干ばつなどの災害がほぼ毎年発生しており、国連国際防災戦略（UNISDR）及び世界銀行によると、モザンビークはアフリカ諸国の中でも気候変動に起因する自然災害のリスクが高い国とされている。国民の 60% 程度がサイクロン・洪水による被害を受けやすい沿岸部・低地に集中しており、両災害による 2000 年～2013 年までの死者は 1,267 名、被災者 674 万人（EM-DAT データベースより）にのぼっているほか、社会・経済面へも大きな被害が出ている。また、13 の主要河川のうち 9 河川は国際河川であり、今後もモザンビーク国内のみならず南アフリカ等の上流国の開発や気候変動の影響により、災害リスクが増大することが懸念される。

しかしながら、モザンビーク政府の防災政策・戦略の内容は、行政管理省傘下の災害管理院（INGC）が主導して実施する緊急時対応や応急対応が主で、防災に係る政策の推進は限定的な状況である。ただ、長らく審議されていた国家災害管理法が 2014 年 6 月に制定されるなど、防災の重要性の認識が高まりつつある。洪水対策は、公共事業住宅水資源省（MOPHRH）傘下の国家水資源局（DNGRH）と地方分権化に伴い設立された地域の流域を管轄する 5 つの地域水管理事務所（ARAs）が実施しているが、両組織はあくまで水資源開発、水資源の有効利用、水環境の管理が主要な役割として認識されており、洪水時にダムや堰で水を貯留するなどの治水対策は実施されていない。そのため DNGRH 及び ARAs に防災を担う部門・課が存在せず、組織改革を含めた見直しを検討する必要がある。加えて、防災に必要な基礎的工学知識をもった人材を国内で養成する環境が十分でない。以上のような背景から、モザンビーク政府は「災害リスク緩和組織能力強化プロジェクト」を要請し、日本政府はこれを採択、2014 年 6 月に国際協力機構（JICA）とモザンビーク側の主なカウンターパート機関となる DNGRH と実施内容を協議し、今後利水のみならず、治水対策の実施など、水関連災害に適切に対応するための組織強化及び技術の習得が必要であることを確認し、案件名を「水関連災害リスク管理組織能力強化支援」とし、協議議事録を署名した。

1.2　業務の目的

本業務の目的等は次のとおりである。

上位目標：
モザンビークにおける水関連災害リスク管理組織能力が強化される。

案件目標：

- DNGRH 及び ARAs の河川管理能力が向上する。
- DNGRH、ARAs 及びその他の防災関連組織による既存の水関連災害管理計画の実施促進能力及び新たな水関連災害管理を実施するための計画策定能力が向上する。

期間：
2014 年 11 月～2018 年 5 月

カウンターパート機関：

（実施機関） DNGRH、ARAs

（協力機関） 企画開発省（MPD）、国家災害管理院（INGC）、国家気象院（INAM）、道路公社（ANE）、国家住宅都市局（DNHU）、土地利用計画局（DNAPOT）、環境活動調整省（MICOA）、農業省（MINAG）

第２章　専門家の構成

JICA 専門家は図 2-1 に示すように、政策アドバイザー1 名、技術アドバイザー4 名、業務調整 1 名で構成された。技術アドバイザーは、それぞれ河川計画、組織開発計画、河川管理技術、衛星データ利活用の各分野を担当した。専門家の従事実績を図 2-2 に示す。

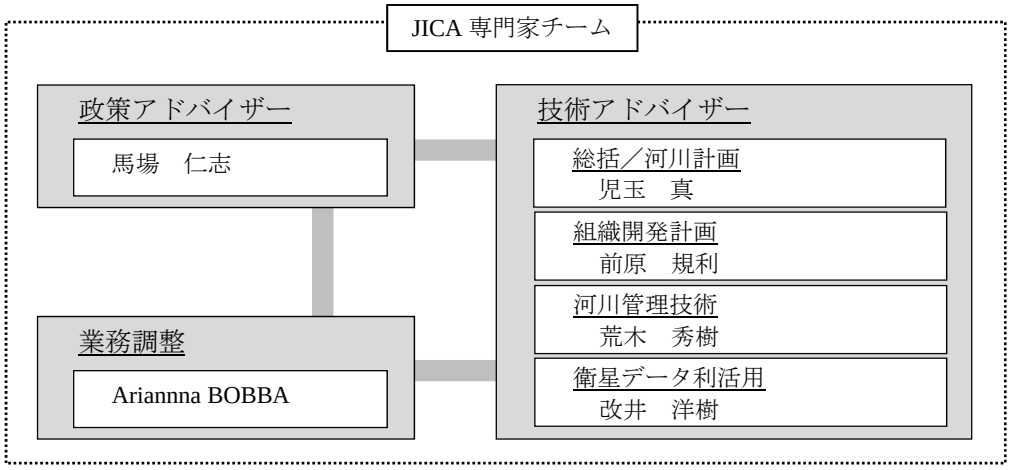


図 2-1　JICA 専門家チームの構成

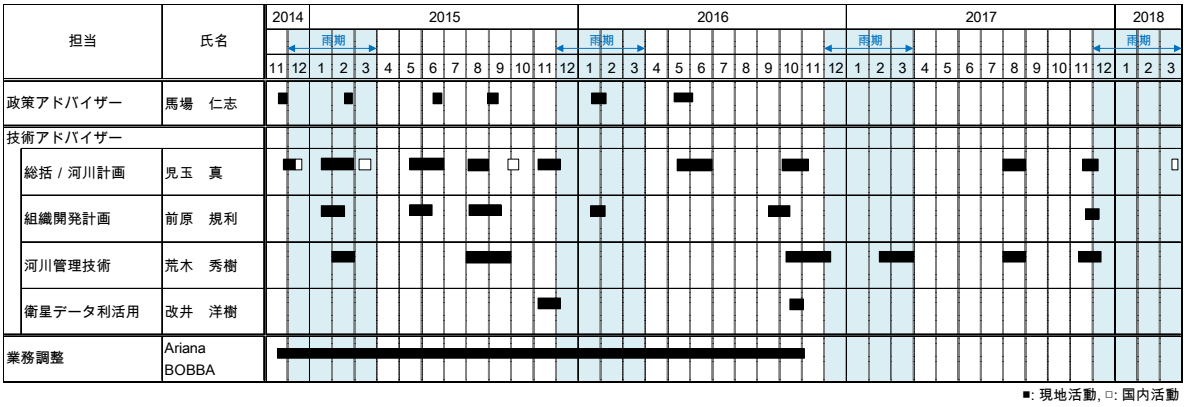


図 2-2　従事実績

第３章　作業計画

本業務の作業工程は次の図 3-1 に示すとおりである。

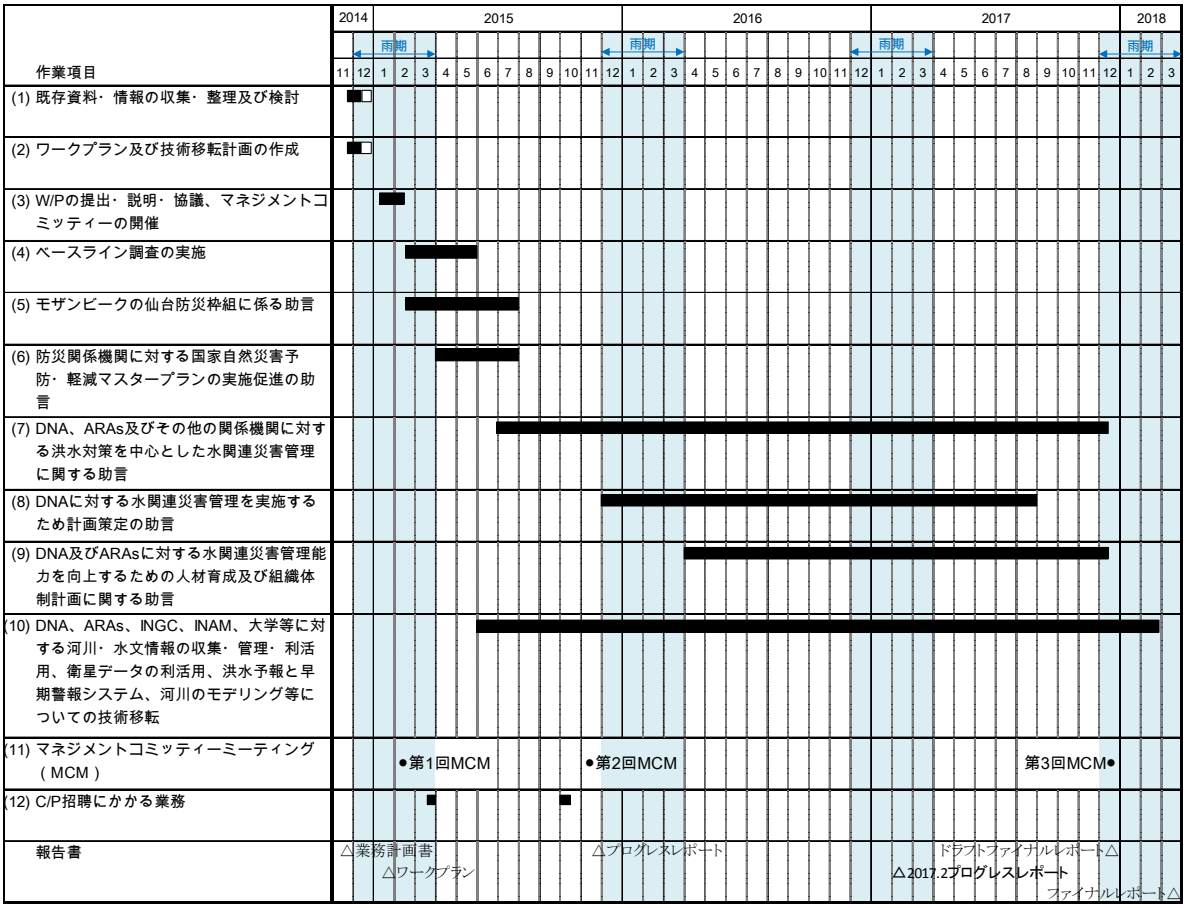


図 3-1　作業計画

第４章　活動

本業務は、2014 年 11 月下旬から 2018 年 5 月上旬までの約 41 ヵ月わたって実施された。業務実施の作業フローは下図に示すとおりである。

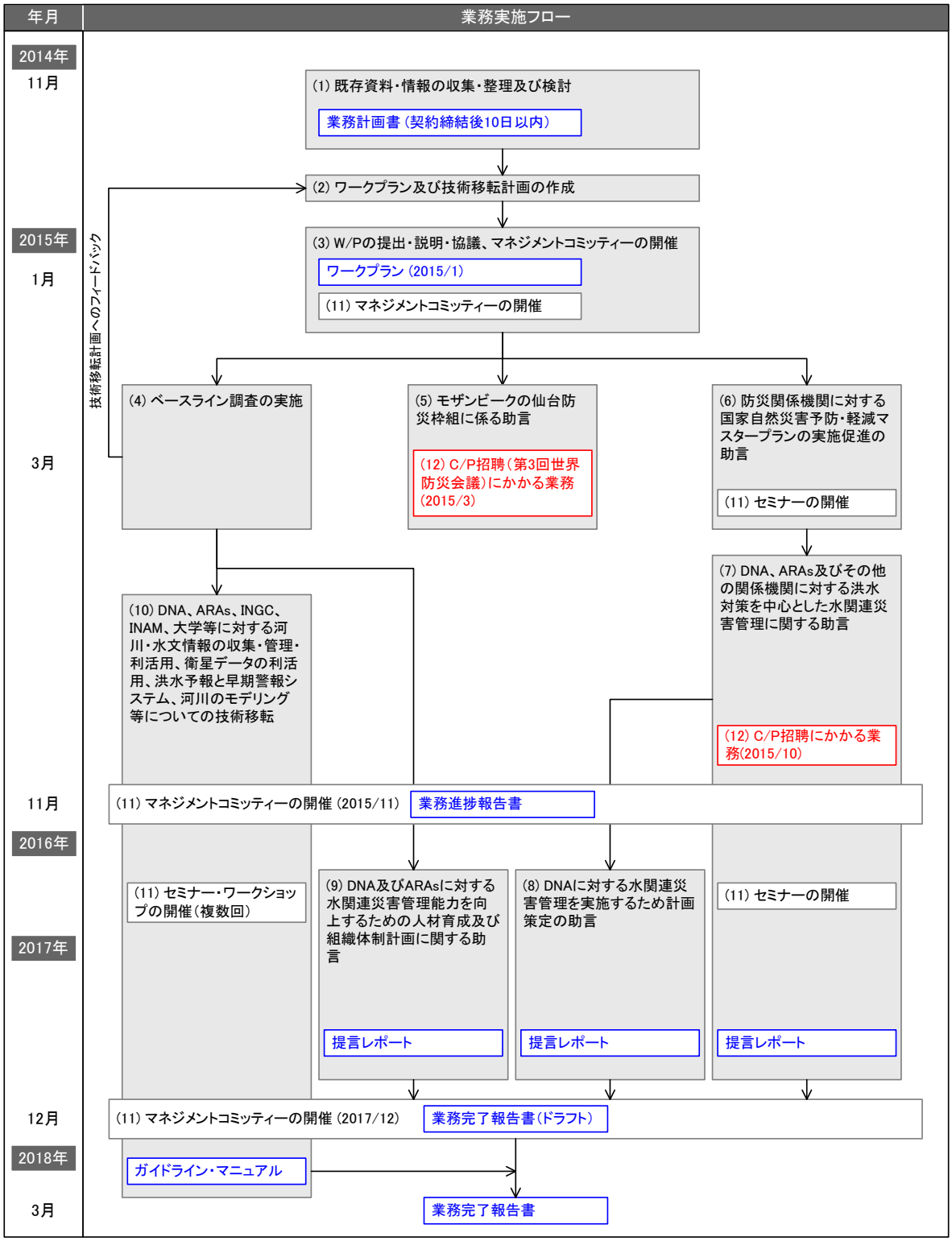


図 4-1　作業フロー

4.1　既存資料・情報の収集・整理及び検討

本業務での具体的な活動内容を検討するために、水関連災害に関係する既存の資料や情報を収集分析し整理するとともに、現地で追加収集すべき情報に関する質問票を作成した。具体的な項目は、主要 13 河川（Maputo 川、Umbeluzi 川、Incomati 川、Limpopo 川、Save 川、Buzi 川、Pungoe 川、Zambeze 川、Licungo 川、Ligonha 川、Lurio 川、Messalo 川、Rovuma 川）の基礎情報、組織体制、流出、氾濫モデルなどである。主要 13 河川については次のようなデータも収集した。

- GIS データ
- DEM データ
- 水文データ
- 河川流域に関する報告書

ここで収集、整理した結果は、「Appendix 2-3 Baseline Survey Report」に取り纏めた。

4.2　ワークプラン及び技術移転計画の作成

本業務を実施するうえでの基本方針、活動内容、実施体制、工程、対象区域、手法等を記載したワークプラン及び技術移転計画を作成した。

4.3　ワークプランの提出・説明・協議、マネジメントコミッティーの開催

2015 年 2 月 19 日に第 1 回マネジメントコミッティーミーティングを開催し、ワークプランを説明し内容について協議した。マネジメントコミッティーは DNGRH、ARAs、INGC、INAM、MEF 等の代表者で構成された。協議の結果、ワークプランの内容について合意を得られた。同会議の協議議事録と発表資料を「Appendix 1-1 Minutes of Meeting on Work Plan / Presentation of Work Plan」に示す。

主な協議内容は以下のとおりである。

(a) 本業務において水関連災害は主として洪水とする。したがって水質や地下水は扱わない。ただし、統合水資源管理の観点から必要に応じて助言することとする。

(b) 地上観測雨量とともに無償版の衛星観測雨量の利活用について技術支援する。

(c) ベースライン調査を実施して現状を把握したうえで活動内容を検討するとともに、水関連災害リスク管理のための組織開発について提言する。

(d) 2015 年 3 月に実施する本邦招聘の参加人数は、DNGRH/ARAs から 5 名、INAM から 1 名の合計 6 名とする。

(e) 河川管理に関する技術移転はパイロットサイトを対象とした OJT を通じて実施する。

(f) 本業務は水関連災害リスク管理に係る技術、知識の指導、支援が目的であり、水文観測に係る機器・機材等の供与はしない。ただし、他のプロジェクト等と協力して水文データ収集の改善を図る。

(g) 業務を通じて技術移転した内容が効果的に展開できるよう JICA チームと C/P の両者でよ

く議論する。

(h) 業務完了後にも技術、知識の向上を継続するために、トレーナーの育成を活動に加えるようモザンビーク側が要請した。

4.4 ベースライン調査の実施

モザンビークの水関連災害リスク管理に関する基本情報を把握することを目的としてベースライン調査を実施した。

(1) 調査項目

表 4-1 に示す項目についてベースライン調査を実施した。調査は基本的に文献調査と関係者への聞き取り調査により実施した。ただし、表中の「4. 組織：防災関連機関のキャパシティアセスメント」は本業務で技術移転する内容、対象、方法などを検討するにあたりとくに重要な項目であると考え、ワークショップを開催して現状把握、課題分析をおこなった。ワークショップについては次の (2)で記述する。

表 4-1 ベースライン調査の項目

項目	細目
1. 主要河川	・自然、社会条件 ・災害履歴 ・その他：水位計、河川構造物、ハザードマップ等
2. 法制度	・National Disaster Management Law ・National Service for Public Rescue Law ・The National Water Law ・その他関連する規則、法令、法律
3. 政策	・Master Plan for Prevention and Mitigation of Natural Disaster (2006-) ・Hyogo Framework for Action (2005-2015) ・Contingency Plan for rainy season and cyclone ・Water Policy ・National Strategy for Water Management
4. 組織	防災関連機関のキャパシティアセスメント： ・人員 ・体制 ・予算 ・ガバナンス等
5. 他ドナー案件	

(2) キャパシティアセスメントワークショップ

JICA チームは、Licungo 川における洪水災害が概ね終息した 2015 年 5 月 27-29 日の 3 日間、パイロットサイトとして選ばれた Licungo 川流域を管理する ARA-Central North を対象に、技術移転セミナーと併せてキャパシティアセスメントワークショップを開催した。

同ワークショップは、ARA-Central North の河川管理機関としての能力・課題の把握を目的としつつ、河川管理、PCM 手法、2015 年洪水への対応の振り返りに関する技術移転も併

せて行った。技術移転セミナー/ワークショップのプログラムを表 4-2 に示す。

キャパシティアセスメントは PCM 手法を用いて行うこととし、PCM 手法に関する講義に引き続きて、参加者を 6-7 名からなる 4 つのグループに分けてグループ討議による分析を行った。JICA 専門家の指示に沿って、河川管理について関係者分析、問題分析、目的分析等を行った。同ワークショップに用いた説明資料を Appendix 2-2 に示す。ワークショップの各ステップにおいて、説明、グループ討議、質疑応答を通じて参加者の理解の促進を図った。同ワークショップを通じたキャパシティアセスメントの結果は DNGRH における 2015 年 6 月 12 日の会議において報告するとともに、ベースライン調査報告書として取りまとめた（Appendix 2-3）。


PCM 手法に関する講義


関係者分析


関係者分析


問題分析


グループ討議


検討結果の発表

写真: キャパシティアセスメントワークショップの様子

表 4-2　技術移転セミナー/キャパシティアセスメントワークショップのプログラム

年月日	プログラム	参加者
2015年5月27日(半日)	**河川管理に関する技術移転セミナー** 目的: 日本の河川管理事例について学び、基本的知識を習得する トピック： ・ 日本における河川管理の歴史 ・ 日本の河川の特性 ・ 日本の河川管理の取組み	27 名 DNGRH (2) ARA-CN (17) ARA-North (4) DPOPHRH-Nampula (1) FIPAG-Nampula (1) INGC-Nampula (1) DPA-Nampula (1)
5 月 28 日(1 日)	**キャパシティアセスメントワークショップ** 目的: パイロット地域における河川管理の能力・課題を明らかにし、問題意識を共有する。 トピック：	

	・ PCM 手法について学ぶ ・ 河川管理にかかわる関係者を明らかにするための関係者分析 ・ 河川管理にかかわる問題分析 ・ 河川管理のあるべき姿を探るための目的分析	
5 月 28 日(1 日)	**2015 年洪水を振返るワークショップ** ・ 様々な災害図上演習について学ぶ ・ Licungo 川流域における 2015 年洪水を振り返るシナリオドリブン型図上演習 ・ 洪水時の対応に関する討議	

(3) ベースライン調査報告書

JICA チームは、ベースライン調査で収集した情報やキャパシティアセスメントワークショップの結果をベースライン調査報告書に取り纏めモザンビーク側へ提出した。同報告書を Appendix 2-3 に示す。ワークショップを通じて得られたモザンビークの河川管理にかかる課題やあるべき姿に向けた取り組みについて、本業務では表 4-3 に示す活動を通じて支援することとした。

表 4-3 ベースライン調査に基づく支援活動

項 目	活 動
1. 水文データの活用	• 水文観測ステーションの点検(特に稼働中のもの) • ARA のユニットによる所管の観測所の水文観測データの品質管理 • 水文観測データの DNGRH/ARAs や INAM への共有の推進
2. 河川施設の管理	• 既存の河川管理台帳の更新 • GIS を活用した河川管理台帳の整備
3. 洪水リスク管理	• 衛星観測雨量を活用した早期警報システムの開発 • 洪水シミュレーションモデルの適用 • 洪水管理計画の策定
4. 人材開発	• DNGRH/ARAs の職員を対象とする統合洪水管理に関する研修カリキュラムの作成

4.5 仙台防災枠組 2015-2030 に係る助言

(1) 兵庫行動枠組みの実施状況のレビュー

モザンビークによる兵庫行動枠組み 2005-2015（Hyogo Framework for Action：HFA）の実施評価に関する報告書 *Report on Implementation of the Hyogo Framework for Action* をレビューし、HFA 後の防災の取組みの方向性について議論、助言するためのセミナーを 2015 年 2 月 19 日に開催した。セミナーの議題は、(a) ポスト HFA（ゼロドラフト）の概要、(b) HFA ならびにポスト HFA に関する JICA の貢献、とした。同セミナーの発表資料を Appendix 3-1 と 3-2 にとりまとめた。

その後、2015 年 3 月に仙台で開催された第 3 回国連防災世界会議（Third UN World Conference on Disaster Risk Reduction：WCDRR）においてポスト HFA として仙台防災枠組 2015-2030 が採

択されたのを受け、同年 6 月 12 日にマプトにおいて仙台防災枠組に関するセミナーを開催し、具体の内容について C/P の理解促進を図った。また、今後はモザンビークにおいても仙台防災枠組の達成に向けた活動が実施されていくことから、統合水資源管理および統合洪水管理に関するセミナーを 2015 年 9 月 15 日に開催した。セミナーの議題と各議題に対応する仙台防災枠組の優先行動を表 4-4 に示す。またセミナーの発表資料を Appendix 3-3 に示す。

表 4-4　仙台防災枠組に関連するセミナー

議題	関連する仙台防災枠組の優先行動
災害対応から災害リスク管理への移行による災害リスクの削減	優先行動 3：　強靭性のための災害リスク削減のための投資
災害リスク削減への投資による災害被害の軽減と緊急対応、復旧のためのコストの縮減	優先行動 3：　強靭性のための災害リスク削減のための投資
各セクターの開発計画への災害リスク削減の導入（防災主流化）に関する組織力の強化	優先行動 2：　災害リスク管理のための災害リスク・ガバナンスの強化
洪水に関するハザード、リスク、インパクトの理解とリスクの評価	優先行動 1：　災害リスクの理解
守るべき目標・レベルの決定	優先行動 2：　災害リスク管理のための災害リスク・ガバナンスの強化

(2)　第 1 回本邦招聘（第 3 回国連防災世界会議への参加）の実施

前述したとおり、2015 年 3 月 14 日～18 日に仙台において第 3 回国連防災世界会議が開催された。同会議の開催に合わせて本邦招聘を実施し、関連会議や各種サイドイベントに参加して世界的な防災の流れや日本の防災技術、東日本大震災からの復興などを学ぶ機会とした。参加人数は DNGRH と ARAs から 5 名、INAM から 1 名の合計 6 名であった。

C/P の業務所掌を考慮して河川管理や洪水リスク管理に関するフォーラムへの参加を中心に日程を作成した（表 4-5）。C/P は非常に熱心に聴講するとともに、講演者に発表資料の提供を依頼する場面もみられた。一日の終わりには振り返りの時間を設けて、その日に見聞きした内容を話し合うことでさらに理解を深めることができた。

仙台での会議のあとに訪れた国土交通省（本省）での講義では河川の等級別の管理、河川計画策定におけるステークホルダーの調整、中央・地方政府の事業費の負担率などについて活発な質疑応答がなされた。また、気象庁での講義では、警報の発令／伝達に関する各機関の責務、避難指示の法的拘束力などについて強い関心が示された。

表 4-5　第 1 回本邦招聘の日程

No	Date	Program
1-2	3/12（木） - 3/13（金）	移動：マプトー羽田
3-7	3/14（土） - 3/18（水）	移動：東京－仙台 **第 3 回国連防災世界会議** 3/14 : パブリックフォーラム「世界と日本の防災政策－津波や地震など大災害への備え」 3/15 パブリックフォーラム「日本の災害への強さ」 　第 1 部－世界の将来に役立つ日本の災害への強さの秘訣と教訓

		第 2 部－防災の将来に役立つ日本の挑戦とイノベーション 3/16：スタディツアー「復興ふくしま～津波被害からの復興と漁業の取組」 相馬市：水産試験場、相馬相双漁業協同組合、松川浦漁港相馬港、和田観光苺組合、光陽サッカー場復興交流支援センター、復興公営住宅 3/17：パブリックフォーラム「大規模洪水対策シンポジウム～低平地都市水害への備え～」 講演 1－オランダにおける新たなリスクベース洪水管理政策 講演 2－レジリエントな高潮対策 講演 3－豪雨災害と三条市の防災対策 パネルディスカッション 3/18：本体会議「ポスト 2015 の採択」 移動：仙台－東京
8	3/19（木）	**国土交通省** 講義：日本の河川行政（日本の河川の特徴、日本の河川管理） **荒川第一調節池** 現地視察：荒川第一調節池
9	3/20（金）	**気象庁** 講義：日本の気象予報業務 視察：観測現業室、予報現業室 **研修評価会**
10-11	3/21（土） - 3/22（日）	移動：成田－マプト

WCDRR：一日の終わりに設けた振り返りの時間

WCDRR：震災復興事業（相馬市松川浦漁港）の見学

WCDRR：復興公営住宅で住民に質問する研修員

国交省：河川管理に関する講義風景

荒川第一調節池：資料館の模型を前に各施設の機能を学ぶ

気象庁：気象観測業務に関する講義風景

写真：第 1 回本邦招聘

表 4-6　第 1 回本邦招聘の参加者

氏名	所属	役職	年齢
Mr. Eduardo Josefa	DNGRH	Civil Engineer, Head of the Hydraulic Public Works Department	39
Mr. Crtistovão Xavier	DNGRH	Geographic Engineer, Focal Point	55
Mr. Danyvan Levy	ARA-South	Civil Engineer	35
Mr. Eurico Saize	ARA-Zambezi	Hydraulic Engineer	39
Mr. Sergio Amela	ARA-Central North	Geographic	38
Mr. Flavio Monjane	INAM	Weather forecast technician, Focal Point	37

4.6　防災関係機関に対する国家自然災害予防・軽減マスタープランの実施促進の助言

業務開始時に国家自然災害予防･軽減マスタープラン（Master Plan for Prevention and Mitigation of Natural Disasters）（2016-）の改訂作業が行われていた。議会の承認が得られたのち、同マスタープランの実施促進に向けた助言をおこなう予定であったが、本業務の活動実施中に国会の承認を受けるまでに至らなかったため、助言に係る活動は実施していない。

改訂前の旧版は 2006 年～2015 年を対象とした計画であった。マスタープラン 2006-2015 年版の概要は以下のとおりである。

国家自然災害予防・軽減マスタープラン（2006-2015 年版）

- 国家自然災害予防・軽減マスタープラン（2006－2015 年版）は、兵庫行動枠組を具体化することを目的として、国家災害管理戦略（1999 年）に基づいて INGC が作成した。
- 同マスタープランは、(a) 乾燥地域における干ばつに対する脆弱性の低減、(b) 自然災害による人的・物的被害の軽減、(c) 自然災害の影響を受ける人数の最小化、(d) 迅速な復旧／復興プロセスの確保、を目標とする。
- また、災害の軽減と備えの促進、具体的には農業保護、非農業分野の収入増、水資源の保全、雨水利用、水資源関連施設（ダムや堤防）などについて言及している。
- 災害管理サイクル（予防、応急対応、復旧復興）における実施事項が記載されているが、各省の責任分担が明文化されていない。

4.7　DNGRH、ARAs 及びその他の関係機関に対する洪水対策を中心とした水関連災害管理に関する助言

(1)　第 2 回本邦招聘の実施

日本の河川管理を学びモザンビークの洪水リスク管理に活かすことを目的として、第 2 回本邦招聘を 2015 年 9 月 28 日～10 月 8 日の日程で実施した。参加者は、DNGRH、ARA-North、ARA-Central North、ARA-Central からそれぞれ 1 名で合計 4 名である。全体の行程と参加者の氏名等を表 4-7、4-8 に示す。

表 4-7　第 2 回本邦招聘の日程

No.	Date	Time	Program
1	28 Sep (Mon)	11:30	マプト発
2	29 Sep (Tue)	21:35	東京（羽田空港）着
3	30 Sep (Wed)	9:00-11:00	オリエンテーション

		13:00-16:00	国土交通省水管理・国土保全局河川計画課国際室 講義：日本の河川行政・洪水対策への取組み
4	01 Oct (Thu)	10:00-12:00	国交省関東地方整備局京浜河川事務所 鶴見川流域センター 講義：鶴見川流域の洪水対策 視察：鶴見川多目的遊水地
		16:30-18:45	移動（東京－新潟）
5	02 Oct (Fri)	9:00-12:00	国交省北陸地方整備局信濃川河川事務所 大河津出張所 見学：大河津資料館 視察：大河津分水（可動堰、洗堰）
		13:00-16:00	新潟県見附市 企画調整課、農政企画係 表敬：久住 見附市長 講義：新潟豪雨災害とその対応 視察：田んぼダム
6	03 Oct (Sat)	9:00-17:00	見学 : 信濃川下流（河口～関谷分水～新潟ふるさと村（道の駅））、新潟市内の古町、寺町
7	04 Oct (Sun)	10:00-11:30	移動（新潟－東京）
		PM	自習
8	05 Oct (Mon)	10:00-16:00	リモートセンシング技術センター 講義：衛星データを利用した地球観測概論 実習：衛星データを利用した水管理・河川管理
9	06 Oct (Tue)	9:00-14:00	リモートセンシング技術センター 実習：衛星データを利用した水管理・河川管理
		15:00-16:00	JICA 評価会
10	07 Oct (Wed)	9:00-13:00 17:10	都内見学（皇居、浅草） 羽田発
11	08 Oct (Thu)	10:45	マプト着

表 4-8　第 2 回本邦招聘の参加者

氏名	所属	役職	年齢
Mr. Carlos Andre Jopela Nhaca	ARA-North	Director General	51
Mr. Francisco Daniel Do Rosario Naene	DNGRH	Chief of Planning and Environmental Section	43
Mr. Edmilson Calos Moises Mahumane	ARA-Central North	Technician of Water Resources Management- Headquarter of ARA-CN	22
Mr. Antonio Germano Melembe	ARA-Central	Technician of Water Resources Management- Headquarter of ARA-N	48

はじめに国土交通省水管理・国土保全局を訪問し、日本の行政による河川管理・洪水対策への取組みを学んだ。C/P からモザンビークの河川行政の現状を説明したり日本の取組に関する質問をしたり活発な発言、議論がなされた。

次に、実際の洪水対策を見学するために国土交通省により整備、管理されている鶴見川多目的遊水地を訪れ、都市域における総合治水対策（河川改修、遊水池、排水ポンプ、調節池、保

水機能の保全、雨水浸透施設など）について学んだ。

		
遊水地全景を望む	遊水地内の建屋の防水扉	遊水池に洪水を導く越流堤

写真：鶴見川遊水池の見学

次の訪問地である新潟県では、信濃川下流の新潟市を頻発する洪水から守るために長い年月と努力の末に完成させた大河津分水の歴史を学んだ。また、洗堰に設置された魚道を観察し、治水だけでなく生物環境にも配慮して施設計画されていることを興味深く学んだ。

		
大河津分水の模型の前で施設の説明を受ける	洗堰の魚道観察室	見附市長への表敬

写真：大河津分水の見学、見附市への表敬

新潟県見附市では市長を表敬し、自治体の限られた予算のなかで知恵を出し工夫しながら以下のようなハードとソフトによる洪水対策を実施しているとの説明を受けた。同市での田んぼダムの視察は、現地の新聞 2 紙と同市のホームページで紹介された（図 4-2）。

ハード対策

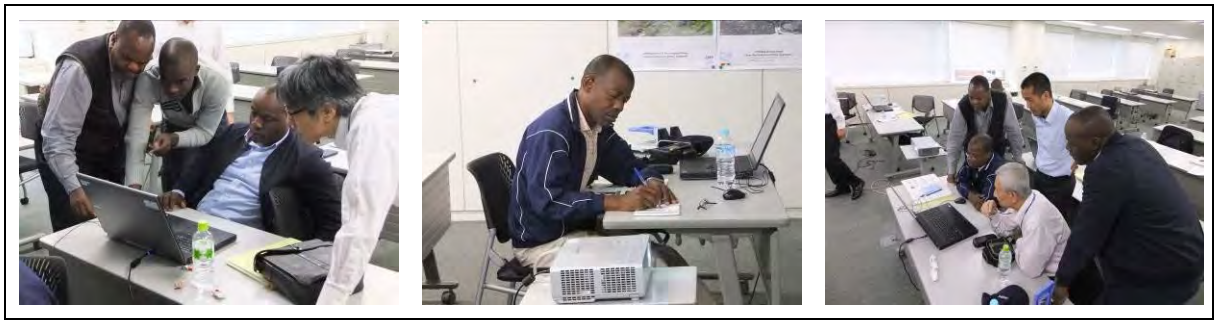
ダムによる洪水調節、遊水池、湾曲部のショートカット、排水ポンプ等

ソフト対策

警報サイレン、防災無線、防災メール、防災ガイドブック、モニタリングシステム等

図 4-2　C/P の視察を伝える新聞、ホームページ

招聘プログラムの最後の 2 日間は、リモートセンシング技術センター（Remote Sensing Technology Center of Japan：RESTEC）において衛星データに関する講義を受けた。リモートセンシング概論を学んだのち、実際に衛星データ（雨量データ、標高データ）を扱う実地研修を受けた。C/P は各種データを取得し、それらを Google Earth に表示させ、河道を抽出する方法などを習得した。C/P からは、ここで得られた技術を自国の洪水リスク管理のために広めていきたい旨の意見が出された。



写真：衛星観測雨量等に関する実地研修

(2)　水関連災害管理に関するセミナーの開催

本業務では、表 4-9 に示すような水関連災害管理に関するセミナーやワークショップを実施した。対象者は、DNGRH、ARAs 及び関係機関の職員で、内容は 2015 年の Licungo 川洪水、日本の洪水管理、水関連災害リスク管理の実施について、等である。

表 4-9　水関連災害管理に関するセミナーの一覧

テーマ	日付/場所	内容
2015 年 Licungo 川洪水	2015 年 2 月 6 日 マプト	1 月 21 日～24 日に実施した Licungo 川洪水の現地調査結果の報告。 内容：水文状況、構造物の被害と原因など。
	2015 年 2 月 26 日 マプト	2 月 20 日～23 日に実施した Licungo 川洪水の第 2 回現地調査の報告。発表資料を Appendix 4-2 に示す。
日本の洪水リスク管理	2015 年 5 月 27 日 ナンプラ	目的： ・ 日本の洪水対策と河川管理を学ぶとともに引き続き実施するワークショップのために災害管理の基礎を理解する。 内容： ・ 日本の河川管理の歴史 ・ 日本の河川の特徴 ・ 日本の河川管理 参加者： ・ DNGRH (2 名) ・ ARA-CN (17 名) ・ ARA-N (4 名) ・ DPOPHRH-Nampula (1 名) ・ FIPAG-Nampula (1 名) ・ INGC-Nampula (1 名) ・ DPA-Nampula (1 名)
	2015 年 6 月 12 日 マプト	目的： ・ 日本の河川管理を事例に河川管理の基礎を学ぶ。 内容： ・ 日本の河川管理の歴史 ・ 日本の河川の特徴 ・ 日本の河川管理 参加者：マネジメントコミッティーのメンバー
水関連災害リスク管理の実施	2015 年 8 月 26 日 モクバ	ワークショップ ・ 河川管理施設の現状調査と施設台帳 ・ わかりやすい災害情報、通信手段、避難指示の発令等
	2015 年 9 月 15 日 マプト	ワークショップ ・ 災害情報の伝達 ・ 統合水資源管理や統合洪水管理による洪水防御と軽減
雨量観測	2015 年 11 月 26 日 モクバ	ワークショップ ・ 雨量観測の方法 ・ 雨量観測の問題点

(3)　水文観測に係る指導

パイロットサイトとして選定した Licungo 川流域の水文観測を実質的に管理している ARA-Central North のモクバ事務所（Mocuba Unit）の職員に対して雨量観測に係る指導をおこなった。はじめに現状の雨量観測について議論、整理したのち、衛星観測雨量の利用や降雨分布、

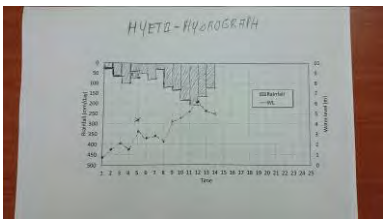
流量観測の実地指導などをおこなった。

現状の雨量観測の体制

- モクバとグルエの水文観測所では、モクバ事務所とその出先機関であるグルエ出張所の職員が自ら雨量、水位、流量を観測している。一方、他の観測所では近隣住民に日雨量、日水位の観測と記録を委託している。
- 近隣住民が観測し記録した水文データは定期的に職員が回収することになっているが、移動に係る車両燃料費や観測員への手当て（700 メティカル/月）のための予算が不足しており回収が滞っている。
- モクバ橋での水位観測は、平常時には 3 回/日（6:00、12:00、17:00）、洪水時には 5 回/日（6:00、9:00、12:00、15:00、17:00）行われている。大出水時などには職員が観測所に留って随時観測している。

水文観測に係る指導

- 衛星観測雨量に関するツール（GSMaP：衛星全球降水マップ、GFAS：Global Flood Alert System）を紹介した。これらのツールを用いて流域全体の降雨分布を確認するとともに、既存の限られた地上雨量観測では流域全体の雨量を的確に捉えられていないことを説明した。
- また、水文観測の基本をイラストを多用して説明している『絵で見る水文観測』を紹介し、そのポルトガル語版（DNGRH に利用されずに保管されていた）を提供した。
- 流量観測に同行し実地指導した。



ハイエトハイドログラフの作成


流量観測

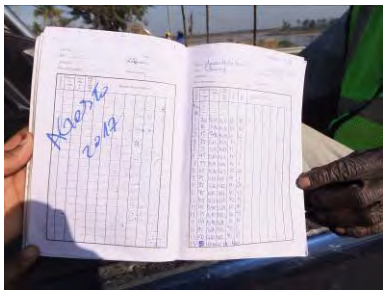

観測流量表

写真　水文観測に関する指導

(4)　河川管理施設台帳に係る指導

河川堤防や護岸、堰、樋門、河川に架かる橋梁などの河川管理施設の状態や問題を把握することは持続的な河川管理に必須であり、これら施設に期待される機能を維持するためには重大な機能不全に至る可能性のある損傷を早期に発見して軽微なうちに補修することが重要となる。そのために、施設台帳を用いた維持管理について以下のような指導をおこなった。

(i)　現地調査

C/P と Licungo 川流域の主要な河川管理施設を回り、施設台帳作成のために座標、標高、

写真等を取得した。また、現状の問題点や被災原因等について以下のような議論をした。

橋梁：橋脚の径間幅の不足による流下物の衝突や取付け護岸の不備による河岸侵食が確認された。橋梁計画時に ARA から道路・橋梁を管轄する ANE に対して適切な指導・助言を与える必要がある。

堤防：2015 年に破堤した堤防の修復が行われているが、一部で高さの低い箇所が残されている。堤防は連続した一定の高さを有することでその機能を発揮するものであることから、次の洪水期までに修復を終える必要がある。

水文観測所：グルエの雨量観測所では雨量計のまわりに柵が設けられていなかった。その他の観測所では柵の設置や除草など適切に管理されていた。一方、水位観測所は 2015 年洪水で水位標が流失したままのものがいくつか確認された。

維持管理：Licungo 川の流域面積は 28,000km^2 と広大なため、定期的に各施設を回って点検していくことは容易でない。施設台帳を活用して優先順位をつけながら効率的に維持管理を継続していくことが重要である。

上述のほかに、氾濫流の挙動に影響を与える地形の調査を実施した。特に、下流左岸のナンテ地区の堤防については、堤防天端と堤内地盤の標高を GPS で押さえて比高の取得を試みた。下流右岸のナマクラ、フルキアでは 2015 年 1 月洪水の浸水範囲の端部を確認して回った。これら結果を整理して後述する洪水氾濫モデルに反映させた。

上記の一連の活動についてモクバで報告会を開催した（2015 年 8 月 26 日）。このときの資料を Appendix 5-2 に示す。

左岸の河岸（写真右側）が大きく侵食されている（ルジェラ）

グルエの雨量観測所：
防護柵が設置されていない

現地での若手職員への指導

簡易地形調査

写真：施設の現状調査ならびに簡易地形調査

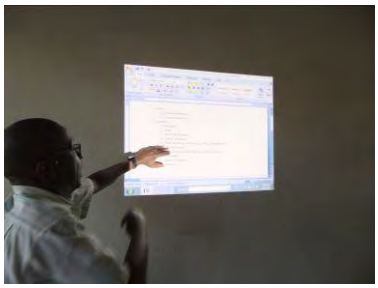
(ii)　河川管理施設台帳

2016 年 5 月 24 日～6 月 3 日にモクバにて河川管理施設台帳に係る研修を実施した。また、約 1 年後の 2017 年 8 月にフォローアップ研修を実施して技術の定着を図った。

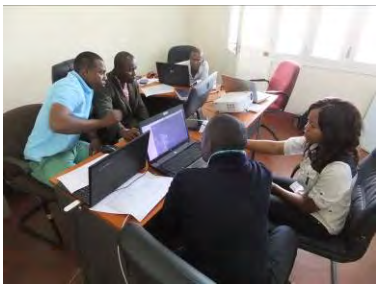
表 4-10　河川管理施設台帳に関する研修の参加者

氏名	所属
Mr. Sergio Amela	ARA-CN, Mocuba Unit
Ms. Marilu Agostihno	ARA-CN, Mocuba Unit
Mr. Victor Bartolomeu　Muaineo	ARA-CN, Mocuba Unit, Gurue office
Mr. Filimao Armando Muude	ARA-CN, Mocuba Unit, Gurue office
Mr. Cristovao Xavier	DNGRH, Water Resource Department

研修は、1) Google Earth に施設等に目印を付ける、2) 施設ごとに台帳を作成する、3) 施設ごとの台帳ファイルを Google Earth 上の目印にリンクさせる、の順で実施した。
対象とする施設や台帳に記載する項目については、参加者で議論して決定した。記載項目は、施設名称、ID 番号、管理者名、流域名、河川名、座標、構造物の分類、運用開始年、状態、警報レベル、観測者の連絡先、被災履歴、写真等とした。
本研修の後、同様の研修を ARA-Central North の職員を対象に実施した。その際には上記の研修参加者（Mr. Sergio Amela）が講師を努めた。



対象施設についての議論



グループ作業

施設見学

写真：施設台帳整備に係る活動

(5)　洪水対応に係る指導

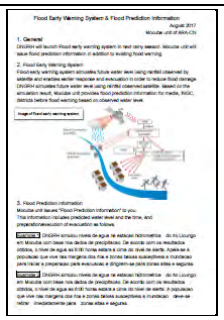
(i)　早期警報システム運用におけるモクバ事務所による洪水対応

本業務では洪水早期警報システムの構築を指導した（4.10 項に詳述）。本システムを 2017/2018 年の雨期より運用開始することを踏まえ、モクバ事務所による洪水対応について以下のような指導をおこなった。

- モクバ橋での水位の観測頻度は、平常時には 3 回/日（6:00、12:00、17:00）、洪水時には 5 回/日（6:00、9:00、12:00、15:00、17:00）である。この観測頻度に基づく観測値を用いて毎時の水位が予測されるものとして、洪水時の対応を検討する。
- 早期警報システム（IFAS/Auto-IFAS）の概要を理解するとともに、「水位上昇を予測して警報を出すことにより、洪水対応や住民避難を早い段階から始めて洪水被害を軽減する」という導入の目的を共通認識とする。この目的を踏まえて対応計画や警報発出

のタイミング等を検討する。

- モクバ事務所が警報を伝える相手は、ARA-CN、モクバラジオ局、INGC のモクバ事務所、モクバ区役所、マガンジャダコスタ区役所（Licungo 川下流左岸）、ナマクラ区役所（Licungo 川下流右岸）である。今までの警報は実測値に基づくものであったが、これに加えて、予測水位による警報を発出することになる。そこで、そのための新たな警報文を検討し作成した。警戒水位に達すると予測された時刻が現時点から 6～4 時間後（避難準備）と 3～1 時間後（避難指示）の 2 通りの警報文の雛型を作成した。
- 前項で挙げた警報伝達先に早期警報システムの導入を説明する資料を作成し、各組織を訪問してシステムの概要や新たな警報の内容について説明した。
- 早期警報システム運用におけるモクバ事務所の対応計画をフロー図として作成した。



早期警報システムの説明資料

関係機関への説明

対応計画フローの検討

写真：洪水時対応の検討

(ii)　わかりやすい災害情報の伝達

モザンビークの中北部地域、特に Licungo 川流域では 2015 年 1 月中旬から 2 月末にかけて大規模な水害に見舞われた。ザンベジア州では 130 人以上が犠牲となり、約 148 千人が被災した。洪水から人的あるいは物的な被害の軽減を図るには、信頼のおける洪水予測に基づいて、また、時間に余裕をもってわかりやすい災害情報が提供されることが欠かせない。

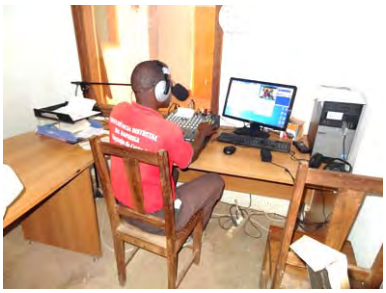
JICA チームは、2015 年 5 月に上記大規模洪水を振り返るワークショップを ARA-CN 事務所を対象に実施した。ワークショップの中で、複数の参加者からコミュニティの人々が DNGRH や ARA が発令する洪水警報の意味を理解していないとの問題点が指摘された。

上記事態に対応するため、JICA チームは DNGRH および ARA-CN と協力して、現状の情報伝達経路、伝達方法、警報メッセージの問題点について中央からコミュニティに至るまで、Licungo 川流域をモデルに 2015 年 8 月 10 日から 9 月 2 日ならびに 2016 年 1 月 20 日から 27 日に現地調査を行った。

調査を通じて収集した情報に基づいて、JICA チームは「わかりやすい災害リスク情報の提供に関する提案」を取りまとめて DNGRH および ARAs へ提出した。取りまとめた内容は「Appendix5-7 Presentation on Easily Understancable Disaster Information」に示す。


Morla コミュニティの防災委員会


Muguloma コミュニティの防災委員会


マガンジャダコスタのコミュニティラジオ局


Musaya の再定住地区


Furquia のコミュニティ防災委員会


Brigodo のコミュニティ防災委員会

写真: 災害情報伝達の問題点把握のための現地調査

4.8　DNGRH に対する水関連災害管理計画策定に係る助言

(1)　洪水防御・軽減ワークショップの開催

DNGRH が水関連災害管理計画を策定するのに資することを目的として、2015 年 9 月 15 日マプトにおいて「統合水資源管理（Integrated Water Resource Management　：IWRM）と統合洪水管理（Integrated Flood Management　：IFM）による洪水防御および軽減ワークショップ」を開催した。JICA チームが DNGRH の職員を対象に IWRM と IFM の概念、洪水リスク管理、災害情報の伝達について講義した。講義資料を Appendix 3-3 に示す。

写真：洪水防御・軽減ワークショップ

(2)　Licungo 川洪水リスク管理計画の策定支援

パイロットサイトである Licungo 川を管理する ARA-CN の職員に対して、同川の洪水リスク管理計画に係る研修を行った。研修はセクションごとに最初に JICA 専門家が講義をし、その後 C/P が実習や検討して発表、議論する構成とした。研修項目ごとの内容や成果は以下のとおりである。

(i) ベースマップの作成

洪水リスク管理計画を検討する際のベースマップを Google Earth を用いて作成した。Google Earth 上に関連事務所や構造物、水文観測所などを「目印」で、河川や堤防などを「パス」で、湖や池を「ポリゴン」で表示させた。また、作成したベースマップを KML ファイルとして保存して他の事務所や職員と共有することができるようになった。

(ii) Licungo 川の流域特性

ベースマップを活用してさまざまな流域特性を抽出して整理、発表した。これらを通じて流域特性の見方やその抽出方法を理解した。具体的には、上下流での流域形状の違いや、河道勾配の変化、河道の蛇行など。

(iii) 2015 年洪水の被害

Licungo 川流域では 2015 年 1 月に発生した洪水により大きな被害を受けた。当時の浸水状況を衛星画像や浸水図を参照し、洪水被害の特徴を議論した。画像や地図から洪水の特徴を読み取る経験がなかったことから少し難しい作業であったが、議論を交えながら進めることで以下のような点を挙げることができた。

- ナンテの上下流で浸水形態が異なる。ナンテ下流の浸水域は広範囲に広がっているのに対して、ナンテより上流の浸水域は河道沿いに限定されている。
- 海岸沿いの微高地に阻まれて氾濫水が直接海に排水されず、結果的に湛水が長期に及んだ。
- 洪水により川に架かる多くの橋が流失、落橋、損壊、橋台まわりの侵食などの被害を受けた。

(iv) 構造物対策

上述した 2015 年洪水の被害を考慮して構造物対策を検討し、対策案をベースマップに表示した。各人が対策案を発表したのち、議論を通じて最終的に最適な組み合わせとなる構造物対策案を決定した。この過程を通じて、C/P は各構造物に求められる機能、状況に応じた対策工の選定、構造物（ハード）と非構造物（ソフト）の組合せによる対策の重要性について理解を深めることができた。

(v) ダムの貯水量の算定

ARA-CN の所長の要請を受け、任意のダム計画地点における貯水容量の算定方法を指導した。指導した算定手順は次のとおりである。 1) GIS（フリーソフトである QGIS を利用）上で DEM を用いてコンターを描く、2) 標高ごとにコンターの面積を計測する、3) エクセルを用いて標高～面積の関係より、標高～貯水量の関係を算定する。

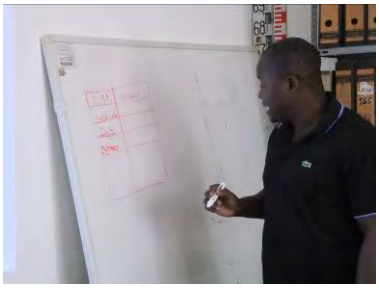
(vi) 非構造物対策

避難計画、土地利用計画、早期警報システムなどの非構造物対策について検討した。また、災害警報の目的は住民に早めの避難を促し人命や資産を守ることであること、そのためには警報文は住民が容易に状況や緊急性を理解できなければならないことを理解した。

(vii) 河川構造物の維持管理

水文観測所を含む個々の河川管理施設の台帳シートをベースマップにリンクさせる方法を

指導した。台帳の作成、整備と巡視点検に基づく更新を通じて適切に河川管理施設を維持管理していくことの重要性を学んだ。

		
研修全景	2015 年洪水に関する発表	ベースマップの作成
		
構造物対策の検討	構造物台帳の説明	構造物台帳の作成

写真：洪水リスク管理計画策定に関する研修

4.9 DNGRH 及び ARAs に対する水関連災害管理能力を向上するための人材育成及び組織体制計画に関する助言

4.4 項で既述したように本業務の開始後、JICA チームは DNGRH および ARAs のベースライン調査を実施して人材育成の現状や組織体制の課題について把握した。その結果、水供給や下水処理に関する研修は行われているものの、河川や洪水の管理に関する研修は実施されていないことがわかった。

また、2015 年 5 月 28 日に ARA-CN を対象に実施したキャパシティアセスメントワークショップでは、参加した職員から洪水管理の様々な場面におけるスタッフの技術的能力の不足が指摘された。

全国を 5 つに区分した地域をそれぞれの ARA が管理すること、また、南北に長い国土の南端に中央政府機関があることから緊急時に中央からの支援が困難な状況を踏まえると、各 ARA が水関連災害管理、統合洪水管理を実施する能力を持たなければならない。

一方、本業務の主要な活動一つとして、水文水理トレーナーの育成ならびに IFAS/ Auto IFAS モデリングトレーナーの育成研修が実施され、DNGRH 内に 6 名のトレーナーが育成された。水文水理に関する知識や IFAS/ Auto IFAS の効果的な活用を全国へ普及するため、トレーナーによる DNGRH や ARAs の技術者、技術スタッフへの技術移転が実施されることを強く推薦する。

JICA チームは、DNGRH と ARAs の水関連災害リスク管理能力の強化のため、人材育成と組織開発について提言レポートを策定した（Appendix 1-5)。DNGRH および ARAs が、今後同提言に基づいて人材および組織の能力強化を図ることが期待される。

4.10 DNGRH、ARAs、INGC、INAM、大学等に対する河川・水文情報の収集・管理・利活用、衛星データの利活用、洪水予報と早期警報システム、河川のモデリング等についての技術移転

洪水管理能力強化に資する技術移転として、以下の 5 分野を中心にとして技術研修、OJT を通じて DNGRH および関係機関への技術移転を実施した。

- 水文データ管理
- 河川シミュレーション技術
- 洪水解析を題材とした技術研修
- 洪水早期警報システム
- 衛星データの利活用

(1) 水文データ管理

DNGRH が管理する水文データ（雨量、水位、流量等）は、複数の水文データベースで管理されている。現状の水文データ管理状況と課題について、担当 DNGRH 職員と共に詳細に確認した。主な活動とその成果を以下に示す。

活動	手法	成果
水文観測所位置の明確化	• 観測所（降雨、水位、流量）リストのレビューと更新 • GIS を用いた観測位置の整理（SHP データおよび、KML データ）	• 水文観測所位置図 • GIS 用 SHP ファイル一式 • Google Earth 用 KML ファイル一式
水文観測所および利用可能な観測記録の状況把握	• 水文データベースに関するインタビュー調査 • 電子化済み（データベース登録済み）水文資料のレビュー • 利用可能水文資料状況の整理	• 水文観測所一覧 • 水文観測資料一覧

DNGRH では、これまでに以下 4 種類の水文データ管理システムを導入、利用してきた。

a) PDP： 雨量、水位、流量データを管理、FORTRAN77 を利用、1940 年代から 1981 年まで稼働

b) HYDRO： 水位データを管理

c) HYDATA： 雨量、水位、流量データを管理

d) Hydstra： 2009 年に各 ARA を含む全国ベースで採用されたが、ライセンス更新のための予算が確保できず 2015 年以降は稼働していない。

各システムの稼働時期

	1940's	1950's	1960's	1970's	1980's	1990's	2000's	2010's
PDP	■	■	■	■	■			
HYDRO		Data converted from PDP			■	■		
HYDATA		Data converted from PDP			■	■	■	■
Hydstra								■

現状では、HYDATA システムを水文データ管理の主システムとして運用し、1940 年代からの水文データを管理している。

技術研修の中でも、水文データの整備状況やその精度について DNGRH 職員と確認を行った。特に既存水文データの課題のとして、時間雨量・時間水位観測資料整備の重要性、観測水位と地盤標高との関係の重要性、大流量時流量観測の不足状況、流量推定方法の必要性について確認し、それらの課題解決の重要性を再認識した。

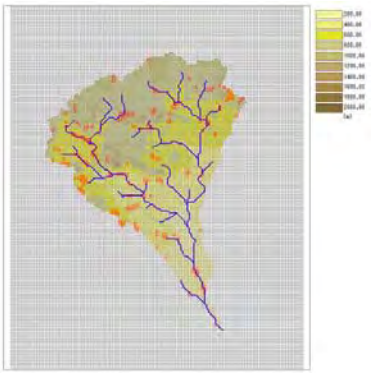
(2) 河川シミュレーション技術

雨量条件から洪水の規模を明らかにする降雨流出解析モデルと、洪水の浸水深と氾濫範囲を推定するための洪水氾濫解析モデルを DNGRH と関連機関に紹介した。これらの解析モデルと解析プロセスの理解は、洪水現象と洪水に対する備えを理解する上で重要なものである。JICA チームは、プロジェクト活動を通して、これらの解析モデルとモデル作成プロセスに関する知識と技術の移転を実施した。

(i) 降雨流出解析モデル

ICHARM（国際水害リスクマネジメントセンター）により開発された IFAS（Integrated Flood Analysis System）を、本プロジェクト活動の降雨流出解析モデルとして採用した。IFAS はオープンソースのソフトウェアであり、衛星観測降雨を用いた洪水予報システムとしての運用も可能である。GSMaP などの衛星観測降雨は、地上降雨観測システムが未整備または不十分な場合、有用な降雨データとなり得る。

DNGRH と協議した結果、モデル解析のパイロットサイトとして Licungo 川流域を選定した。DNGRH を対象としたモデル作成の OJT および DNGRH と各 ARA を対象とした技術研修を通じて、Licungo 川流域の IFAS モデルを開発した。



IFAS モデルイメージ

IFAS 出力例（Mocuba 地点）

IFAS モデル作成に関する OJT および技術研修を通して、DNGRH 職員と研修受講生は以下の事項を理解、習得した。

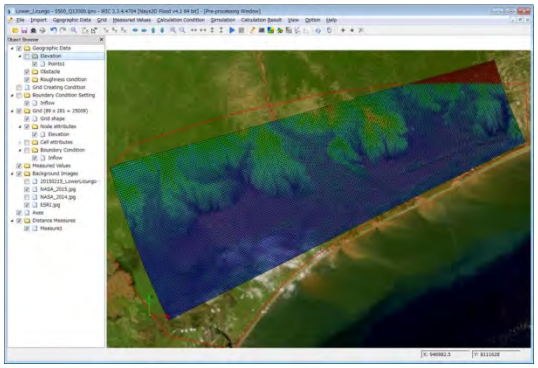
- USGS HydroSHEDS サイトからの関係 GIS データの入手方法
- IFAS モデル入力：DEM データ
- IFAS モデル入力：土地利用データ
- IFAS モデル入力：雨量データ（地上観測雨量、衛星観測雨量）
- IFAS モデルパラメータ
- IFAS モデルの作成方法
- IFAS モデル同定方法
- IFAS モデル出力：流量ハイドログラフ
- IFAS モデル出力：流域平均雨量
- IFAS モデルを利用した洪水早期警報システム

(ii)　洪水氾濫解析モデル

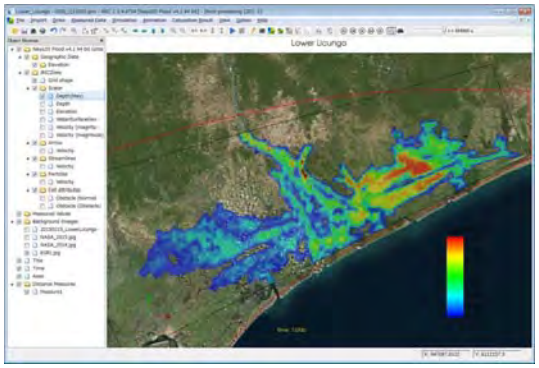
洪水氾濫解析モデルとして、iRIC（International River Interface Cooperative）が開発した iRIC Nays2Dflood を採用した。iRIC Nays2Dflood は、オープンソースのソフトウェアであり、非定常 2 次元平面流シミュレーションに基づく洪水氾濫解析ソルバーとしての利用が可能である。

DNGRH 職員を対象としたモデル作成の OJT および DNGRH と ARA-CN を対象とした技術研修を通じて、Licungo 川下流の常習氾濫域およびモクバ橋周辺の iRIC Nays2Dflood モデルを作成した。

iRIC Nays2Dflood を用いて 2015 年 1 月洪水の再現シミュレーションを実施した結果、洪水の実績氾濫範囲（衛星写真）と比較して、精度の高い再現性を確認した。これらの洪水氾濫解析を通じて、DNGRH および ARA-CN 職員は、洪水リスク管理ツールとしての洪水流解析モデルの有効性を理解した。



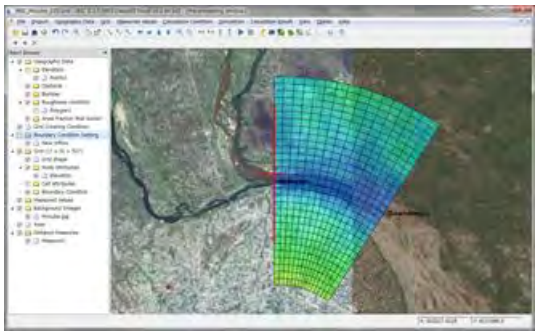
iRIC Nays2Dflood モデル



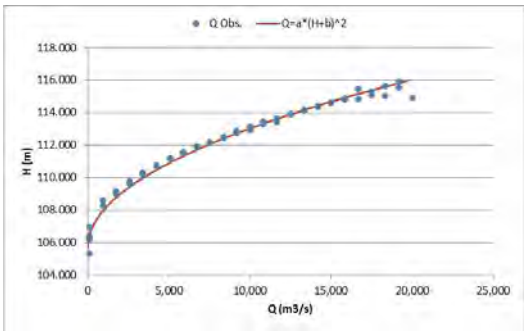
iRIC Nays2Dflood 結果（Licungo 下流）

モクバ橋周辺の iRIC Nays2Dflood モデルの計算結果を、モクバ橋水位観測所での H-Q 関係の推定に利用した。しかしながら、実流量の推定には、モデル計算水位（標高）と観測水

位記録（水位標の読み値）との正確な関係が必要となることを明確にした。



iRIC Nays2Dflood モデル



H-Q 関係の推定

洪水氾濫解析モデル作成に関する OJT および技術研修を通じて、DNGRH 職員と研修受講生は以下の事項を理解・習得した。

- USGS Earth Explorer サイトからの関係 GIS データの入手方法
- GIS（QGIS）を用いた iRIC Nays2Dflood モデル用背景図の作成手順
- GIS（QGIS）を用いた DEM データからのモデル用標高データの作成手順
- iRIC Nays2Dflood モデル用粗度係数設定手順
- iRIC Nays2Dflood モデル出力の洪水氾濫範囲の確認手順
- iRIC Nays2Dflood モデル出力の地点水位ハイドログラフの確認手順
- iRIC Nays2Dflood モデル出力を用いた H-Q 関係の推定方法

(3)　洪水解析を題材とした技術研修

プロジェクト活動期間中、以下の計 5 回の技術研修を実施した。

1:　2015 年 08 月：洪水解析モデル作成（第 1 回）DNGRH（Maputo）会場
2:　2015 年 08 月：洪水解析モデル作成（第 2 回）ARA-CN（Nampula）会場
3:　2016 年 10 月：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 1 回）
4:　2016 年 11 月：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 2 回）
5:　2017 年 08 月：水文トレーナー育成技術研修

(i)　2015 年 08 月：洪水解析モデル作成（第 1 回、第 2 回）

10 日間の技術研修として「洪水解析モデル作成」研修を DNGRH（マプト）会場および ARA-CN（ナンプラ）会場で開催した。DNGRH 会場では 9 の関係機関からの計 15 名の研修生が、ARA-CN 会場では 10 の関係機関からの計 22 名の研修生が、それぞれの研修に参加した。

研修生は、モデル作成の実習講義を通じて、IFAS モデル（衛星観測降雨を用いた降雨流出モデル）および、前述の iRIC Nays2Dflood モデル（2 次元氾濫解析モデル）の基本的な作成手法を習得した。また、研修生は GIS ソフト（QGIS）や表計算ソフト（Excel）を活用したモデル用入力データの作成等、関係周辺技術についても習得した。さらに、オープン

ソースとして利用できる DEM データ（SRTM-1Arc、ASTER GDEM、GMTED2010 等）や流域界・河川網データ（USGS HydroSHEDS）等の GIS データの情報が共有され、モデル作成に利用された。

各種 GIS データを提供するサイトの例：USGS “Earth Explorer”

主な研修講義内容を以下に示す。

- IFAS モデル作成
- iRIC Nays2Dflood モデル作成
- GIS データ（USGS Earth Explorer、USGS HydroSHEDS）のダウンロード操作
- 測地系の理解（WGS84、WGS84/UTM36S、WGS84/UTM37S 等）
- GIS（QGIS）ソフトの基本操作
- QGIS を用いたモデル背景図の作成
- QGIS を用いた DEM データからのモデル用標高データの作成
- Excel を用いた H-Q 式（水位－流量関係式）の推定手法
- Excel の Pivot Table 機能を用いた水文データの整理手法

DNGRH 会場および ARA-CN 会場での、研修プログラム、研修風景写真、研修受講生リストを以下に示す。

研修プログラム：DNGRH（Maputo）会場

Day	Date	Description
01	10 Aug. (Mon)	AM: LAN setting Orientation Outline of Models for flood analysis PM: PC setting (Internet connection) and installation of modeling software (IFAS, iRIC, QGIS, Google Earth Pro, Excel, etc.)
02	11 Aug. (Tue)	Basic IFAS modeling by using sample input data
03	12 Aug. (Wed)	Basic iRIC Nays2Dflood modeling by using sample input data
04	13 Aug. (Thu)	Preparation of input data for the modeling by using GIS - Tip on coordinate system (WGS84 WGS84/UTM 36S) - Download DEM (USGS Earth Explorer) - Base map for QGIS (add. QGIS Plugin) - Background satellite images for iRIC
05	14 Aug. (Fri)	Preparation of input data for the modeling by using GIS - DEM for iRIC (*.tpo) (Ref. : Nays2D_Flood_Examples_en20150623.pdf) - Watershed shape (USGS HydroSHEDS) - River network vector data (SHP file)
06	17 Aug. (Mon)	Preparation of input data for the modeling by using GIS - River cross-section (add. QGIS Plugin) iRIC modeling (estimation of H-Q curve at IFAS calibration point) (1/2)
07	18 Aug. (Tue)	iRIC modeling (estimation of H-Q curve at IFAS calibration point) (2/2) IFAS modeling and calibration for Licungo River basin (1/2)
08	19 Aug. (Wed)	IFAS modeling and calibration for Licungo River basin (2/2)
09	20 Aug. (Thu)	iRIC Nays2Dflood modeling and calibration for Licungo River basin
10	21 Aug. (Fri)	Closing technical discussion Supplementary session "Hydrological data management" - Using Excel's "Pivot Table"

モデル作成講義：DNGRH（Maputo）会場

研修受講生リスト：DNGRH（Maputo）会場

1	Sr. Isac Filimone	DNGRH/DGBH	9	Sr. Abu Jamal	ARA-SUL
2	Sr. Armando Cuinhane	DNGRH/DGBH	10	Sra. Adalgisa Tinga	ARA-SUL
3	Sr. Valdemiro Escola	DNGRH/DGBH	11	Sr. Teodomiro Cabral	ARA-SUL
4	Sr. Agostinho Vilanculo	DNGRH/DGBH	12	Sr. Salvador Mamela	ARA-Zambeze

5	Sra. Isabel Fotine	DNGRH/DRI	13	Sra. Felisbela Mulaveia	ARA-Centro
6	Sra. Marlen Maciel	DNGRH/DP	14	Sr. Manuel Francisco	INAM
7	Sr. Valter Machatine	DNGRH/DAS	15	Sr. Dennis Guiamba	INGC/CENOE
8	Sr. Leonel Bila	ARA-SUL			

研修プログラム：ARA-CN（Nampula）会場

Day	Date	Description
01	27 Aug. (Thu)	AM: LAN setting Orientation Outline of Models for flood analysis PC setting (Internet connection) and installation of modeling software (IFAS, iRIC, QGIS, Google Earth Pro, Excel, etc.) PM: Basic iRIC Nays2Dflood modeling by using sample input data
02	28 Aug. (Fri)	Basic IFAS modeling by using sample input data
03	31 Aug. (Mon)	- Tip on coordinate system (WGS84, WGS84/UTM 37S) Google Earth QGIS - Base map for QGIS (OpenLayers Plugin) - Background satellite images for iRIC
04	01 Sep. (Tue)	Preparation of input data for the modeling by using GIS - Watershed shape (USGS HydroSHEDS) Licungo river basin shape - River network Shape (USGS HydroSHEDS) Licungo river basin river network shape
05	02 Sep. (Wed)	Preparation of input data for the modeling by using GIS - Download DEM (USGS Earth Explorer) Merge DEM - Merge DEM (Raster-Miscellaneous-Merge) - DEM for iRIC (*.tpo) Clip DEM (Raster-Extraction-Clipper) Convert to UTM (Raster-Project-Warp) Convert to ASCII format (Rater-Conversion-Translate) Prepare *.tpo file format by Excel
06	03 Sep. (Thu)	Estimation of H-Q curve - iRIC Nays2DFlood Nays2DFlood “Mocuba model” Input Data: DEM (*.tpo), Background image, Inflow - Application of H-Q formula $Q(m^3/s) = a \times (H(m)+b)^2$
07	04 Sep. (Fri)	Hydrological Data Management - River water-level => Discharge Application of Excel “Pivot Table” tool - Example: Daily Rainfall River cross-section (QGIS: Profile tool)
08	08 Sep. (Tue)	IFAS modeling and calibration for Licungo River basin
09	09 Sep. (Wed)	Review of IFAS model output - Understanding of discharge hydrograph features
10	10 Sep. (Thu)	Closing technical discussion Closing Lecture Observation of Precipitation from Satellites (by Dr. Baba)

馬場専門家ガイダンス

モデル作成講義

研修風景：ARA-CN（Nampula）会場

研修受講生リスト：：ARA-CN（Nampula）会場

1	Sr. Ivan Uamusse	ARA-CN	12	Sr. Norton Amisse	ARA-CN/Mocuba
2	Sr. Edmilsom Mahumane	ARA-CN	13	Sra. Marilu Agostinho	ARA-CN/Mocuba
3	Sr. Paulino Machava	ARA-CN	14	Sr. Aristides Bahane	ARA-CN/Nacala
4	Sr. Felix Malala	ARA-CN	15	Sr. Meireles Oscar Mustafa	ARA-CN/Namapa
5	Sra. Eleonora Saize	ARA-CN	16	Sr. Herminio Mario	ARA-CN/Namapa
6	Sr. Isaque Massitela	ARA-CN	17	Sr. Constancio Sembe	ARA-NORTE
7	Sr. Eusebio Tomas	ARA-CN	18	Sr. Abudo Comecar	INGC
8	Sr. John Gouvindo	ARA-CN	19	Sr. Rui Domingos Ramos	DPOPH
9	Sr. Victor Bartolomeu Muacinco	ARA-CN/Gurue	20	Sr. Arlindo Issa	DPOPH
10	Sr. Filimao Munde	ARA-CN/Gurue	21	Sr.Justino Candido	DPASA - NPL
11	Sr. Sergio Anela	ARA-CN/Mocuba	22	Sr. Hugo Chidengo	FIPAG - NPL

(ii)　2016 年 10 月：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 1 回）

2016 年 10 月 17～28 日に 10 日間、マプト DNGRH 会議室において、河川シミュレーションに関する技術研修として「IFAS・AutoIFAS（洪水予測・早期警報）システム構築」研修を実施した。

ARA-Sul：4 名、ARA-Centro：1 名、ARA-Norte：2 名、ARA-Centro Norte /Mocuba Unit：2 名、DNGRH/DOH：1 名の計 10 名がこの研修に参加した。

研修受講生リスト：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 1 回）

Ms. Adalgisa Tinga	ARA Sul	Mr. Antonio Cipriano	ARA Norte
Mr. Leonel Bila	ARA Sul	Mr. Costancio Simbe	ARA Norte
Mr. Abu Jamal	ARA Sul	Mr. Sergio Anela	ARA CN/ Mocuba
Mr. Roberto Chauque	ARA Sul	Ms. Marilu Agostinho	ARA CN/ Mocuba
Mr. Delton Nhaia	ARA Centro	Mr. Belarmino Manuel Chivambo	DNGRH/DOH

研修は IFAS を用いた流出解析および AutoIFAS の設定を理解・習得・活用することを目的として、実習・演習を中心に Licungo 川流域を対象としたモデル構築を習得した後、研修

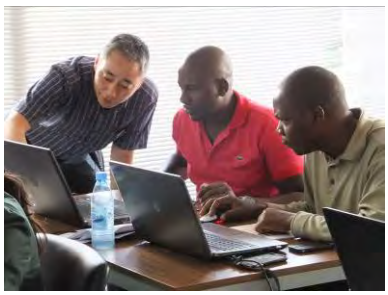
後半では各 ARA が管轄する流域を対象に独自モデルの構築演習を実施した。最終日には各 ARA の代表者がモデルの構築状況を発表し、モデルの構築の課題点等を共有した。

研修にあたっては、受講者の進捗に応じて研修プログラムを柔軟に調整・変更し、最終的に以下のプログラムで研修を実施した。

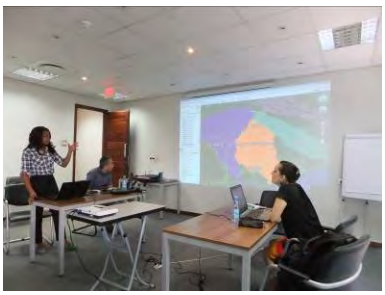
研修プログラム：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 1 回）

Day	Date	Description
01	17 Oct. (Mon)	• DNGRH LAN (Wi-Fi) setting • Programs setup (Google Earth Pro, QGIS, IFAS and AutoIFAS) - Basic information of the PC - Tips for windows setting and installation • Outline of IFAS and Auto IFAS • Data preparation for IFAS - Shape file of the objective basin (USGS HydroSHEDS) - Shape file of the main river course (USGS HydroSHEDS) - Data preparation by using QGIS - Viewing Shape file by using Google Earth Pro
02	18 Oct. (Tue)	• Review of GSMaP data • IFAS modeling (1/2) for Licungo Basin
03	19 Oct. (Wed)	• IFAS modeling (2/2) for Licungo Basin
04	20 Oct. (Thu)	• Application of rating curve (water-level & discharge relation) • Model calibration (1/2) for IFAS Licungo model
05	21 Oct. (Fri)	• Model calibration (2/2) for IFAS Licungo model
06	24 Oct. (Mon)	• Auto IFAS settings (1/2)
07	25 Oct. (Tue)	• Auto IFAS settings (2/2) • Self-practice of IFAS applying to other basins (1/3)
08	26 Oct. (Wed)	• Self-practice of IFAS applying to other basins (2/3)
09	27 Oct. (Thu)	• Self-practice of IFAS applying to other basins (3/3)
10	28 Oct. (Fri)	• Presentation by each ARA and technical discussion • Closing supplementary lecture: - "Development of H-Q curve" by using Excel functions

モデル作成講義



専門家指導



各 ARA の発表

研修風景：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 1 回）

2015 年に実施した河川シミュレーションに関する技術研修では、受講生の専門知識や PC スキルにバラツキがあり、研修内容の理解度と研修の進捗に大きく影響したことを教訓に、この研修では、2015 年の研修受講生を中心に、基礎的な専門知識・PC スキルを持つことを受講要件として 10 名に限定して受講生を募集した。この結果、研修に必要な基礎知識を十分に有した受講生が研修に参加した。特筆すべきは、全研修課程を通じて、各 ARA に 1

名、計 5 名の受講生は研修内容の理解が早く特に優秀であると評価できた点にある。

受講生は、本研修を通して IFAS および AutoIFAS モデル構築の一連の手順とモデル利用の注意点を習得した。また、モデル構築に不可欠な GIS（QGIS）や Excel を用いた入力データの準備、検証等の周辺技術を併せて習得した。さらに、各 ARA の独自流域モデルの作成実習においては、理解の早い受講生が他の受講生に指導するまでにモデル構築の理解を深めていた。

研修最終日には、各 ARA の代表者が各 ARA モデルの構築状況・課題を発表し、水位観測・流量観測資料の整備状況、水位観測頻度の課題、H-Q 作成時の異常値棄却、エラー発生時の対処等のモデル構築時の技術的課題等を受講生全員で共有、討議した。

研修実施に合わせて、以下の 3 つの技術マニュアルをポルトガル語に翻訳し、電子データと共に受講生に配布・共有した。

- IFAS Quick Reference
- IFAS (Ver.2.0) Technical Manual
- AutoIFAS Operating Manual

IFAS Quick Reference

IFAS (Ver.2.0)
技術マニュアル

AutoIFAS Operating Manual

(iii) 2016 年 11 月：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 2 回）
2016 年 11 月 7 日～18 日にマプト DNGRH 会議室において、河川シミュレーションに関する技術研修として、第 1 回研修とは別の受講生を対象に「IFAS・AutoIFAS（洪水予測・早期警報）システム構築」研修（第 2 回）を実施した。

DNGRH/DGBH：4 名、ARA-Centro：1 名、ARA-Zambezi：2 名、ARA-Centro Norte：2 名の計 9 名が本研修に参加した。

研修受講生リスト：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 2 回）

Mr. Agostinho Vilanculo	DNGRH /DGBH
Ms. Filoca Fondo	DNGRH /DGBH
Mr. Armando Cuinhane	DNGRH /DGBH

Mr. Jose Alvaro Malanco	DNGRH /DGBH
Mr. Moises Rosario Napintela	ARA Centro /Beira
Mr. Eurico Filisberto Saize	ARA Zambezi /Tete
Mr. Nélio Julio Boaventura Zunguze	ARA Zambezi /Tete
Mr. Filimao Armando Munde	ARA CN /Gurue
Mr. Paulino Devisse Machava	ARA CN /Nampula

研修は第 1 回研修と同様に、IFAS を用いた流出解析および AutoIFAS の設定を理解・習得・活用することを目的として、実習・演習を中心に Licungo 川流域を対象としたモデル構築を習得した後、研修後半では各 ARA に関係する流域を対象に独自モデルの構築演習を実施した。最終日には各 ARA の代表者がモデルの構築状況を発表し、モデルの構築の課題等を共有した。

研修にあたっては、受講者の進捗に応じて研修プログラムを柔軟に調整・変更し、最終的に以下のプログラムで研修を実施した。

研修プログラム：IFAS・AutoIFAS（洪水予測・早期警報）システム構築（第 2 回）

Day	Date	Description
01	07 Nov. (Mon)	• DNGRH LAN (Wi-Fi) setting • Programs setup (Google Earth Pro, QGIS, IFAS and AutoIFAS) - Basic information of the PC - Tips for windows setting and installation • Outline of IFAS and Auto IFAS • Data preparation for IFAS - Shape file of the objective basin (USGS HydroSHEDS) - Shape file of the main river course (USGS HydroSHEDS) - Data preparation by using QGIS - Viewing Shape file by using Google Earth Pro
02	08 Nov. (Tue)	• Review of GSMaP data • IFAS modeling (1/2) for Licungo Basin
03	09 Nov. (Wed)	• IFAS modeling (2/2) for Licungo Basin
	10 Nov. (Thu)	(National Holiday)
04	11 Nov. (Fri)	• Model calibration (2/2) for IFAS Licungo model
05	14 Nov. (Mon)	• Auto IFAS settings (1/2)
06	15 Nov. (Tue)	• Auto IFAS settings (2/2) • Self-practice of IFAS applying to other basins (1/3)
07	16 Nov. (Wed)	• Self-practice of IFAS applying to other basins (2/3)
08	17 Nov. (Thu)	• Self-practice of IFAS applying to other basins (3/3)
09	18 Nov. (Fri)	• Presentation by each ARA and technical discussion • Closing supplementary lecture: - "Development of H-Q curve" by using Excel functions

研修実施にあたって、第 1 回研修と同様に、以下のポルトガル語版マニュアルを電子データと共に受講生に配布した。

- IFAS Quick Reference
- IFAS (Ver.2.0) Technical Manual
- AutoIFAS Operating Manual

第 1 回研修同様、2015 年研修の受講生を歓迎すると共に、基礎的な専門知識・PC スキルを持つことを受講要件として 10 名に限定して受講生を募集した。この結果、研修に必要な基礎知識を有した受講生が研修に参加した。また、第 1 回研修と同様に、全研修課程を通じて各 ARA に 1 名、計 5 名の受講生は、研修内容の理解も早く特に優秀な受講生であったと評価できる。

受講生は、本研修を通して IFAS および AutoIFAS モデル構築の一連の手順とモデル利用の注意点を習得した。また、モデル構築に不可欠な、GIS（QGIS）や Excel を用いた入力データ準備、検証等の周辺技術も併せて習得した。また、各 ARA の独自流域モデルの作成実習においては、理解の早い受講生が他の受講生に指導するまでに、モデル構築の理解を深めていた。

研修の後半、他プロジェクトのミッション対応など担当業務が多忙となり、DNGRH/DGBH の受講生が研修後半の課程を修了するに至らなかった。このため、研修終了後も引き続き DNGRH/DGBH 職員を対象に研修のフォローアップを継続実施した。

研修最終日には、各 ARA の代表者が各 ARA モデルの構築状況・課題を発表し、第 1 回研修と同様に、水位観測・流量観測資料の整備状況、水位観測頻度の課題、H-Q 作成時の異常値棄却、エラー発生時の対処等を中心に、モデル構築時の技術的課題等を受講生全員で共有・討議した。

(iv)　2017 年 08 月：水文トレーナー育成技術研修

AutoIFAS 洪水早期警報システムのより実践的かつ継続的な利用を目的とし、水文学や河川工学の講義を取り入れた「水文トレーナー育成技術研修」を実施した。

研修コースの目的

- AutoIFAS システム管理責任者（System Manager）および AutoIFAS システム運用主任（System Operation and Maintains (O/M) Specialists）のシステム管理・運用能力の向上
- DNGRH および ARA 職員への技術指導を目的とした水文トレーナーとしての能力の向上

研修対象者

- AutoIFAS システム管理責任者（System Manager）：洪水早期警報の発信を含むシステムの統括管理責任者
- AutoIFAS システム運用主任（System Operation and Maintains (O/M) Specialists）：システム異常時の対処を含むシステムの日常的な運用・管理責任者

DNGRH/DGBH と協議の結果、以下の 6 名が研修対象者として選出され研修に参加した。

1) Mr. Agostinho Vilanculo
2) Mr. Jose Alvaro Malanco
3) Mr. Isac Filimone
4) Mr. Armando Cuinhane
5) Ms. Filoca Fondo
6) Mr. Leno Gomes

JICA 専門家の指導の下、以下に示す 9 日間の研修プログラムに沿って、水文トレーナー育成技術研修（AutoIFAS 洪水早期警報システム活用）が実施された。

研修プログラム：水文トレーナー育成技術研修（AutoIFAS 洪水早期警報システム活用）

Day	Subject	Remarks
Day 1 08 Aug. (Tu)	• Guidance of Training course • Review of outline of AutoIFAS, AutoRainDownload, IFAS, GSMaP, GFAS, QGIS, Google Earth Pro, VMware • Review of available manuals • How to get required free software • Self-practice of checking PC's hardware capabilities (CPU, RAM, HDD, OS, Language setting) • Self-practice of software installation	Lecture and Self-practice
Day 2 09 Aug. (We)	• Review and learn on software installation problem • Self-practice of software installation and IFAS modelling • Error handling for IFAS modeling	Lecture and Self-practice
Day 3 10 Aug. (Th)	• Lecture on Hyetograph, Hydrograph, H~Q relation, Uniform flow vs Non-uniform flow, Steady flow vs Unsteady flow • Understanding the hydrological observation network and available data (rainfall, water-level and discharge) in Mozambique • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (1/3): using observed data • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (2/3): using uniform flow calculation result	Lecture and Self-practice
Day 4 11 Aug. (Fr)	• Application of MIKE11 for cross-section's A and R • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (3/3): using 2D flow simulation results • IFAS calibration (1/2)	Lecture and Self-practice
Day 5 14 Aug. (Mo)	• IFAS calibration (2/2)	Self-practice
Day 6 15 Aug. (Tu)	• Overall AutoIFAS setup • AutoIFAS setting on E-mail alert delivery • AutoIFAS test run	Self-practice
Day 7 16 Aug. (We)	• AutoIFAS operation drill using 2015 flood event • Discussion and preparation of alarm level • Discussion and preparation of alarm delivery protocol • Practice of alarm delivery protocol • Preparation of 1 day Training program (for Day 09)	Lecture, Self-practice and discussion

Day	Subject	Remarks
Day 8 17 Aug. (Th)	• Case study on Operation and Maintenance of AutoIFAS ➢ Power failure ➢ Network failure ➢ Error messages • AutoIFAS outputs review • LAN setting for GSMaP data download in DNGRH • Overall review	Lecture and Self-practice Trainees will organize 2 days training as trainer.
Day 9 18 Aug. (Fr)	Training Practice for IFAS and AutoIFAS modelling (08:00 ~ 15:00, Venue: DNGRH/DGBH)	Inviting 4 beginner trainees from DGBH and ARA-Sul.

なお、研修コースで使用する全ての資料・マニュアル類は、ウェブストレージ（Google Drive）に保存し、研修生が必要な時にいつでもインターネットを通じて資料を参照できることとした。(https://drive.google.com/drive/folders/0B9mP2S0_MYRfY1RpMFpPR0NtbHM)

研修コースの最終日には、以下 4 名の DNGRH/DGBH および ARA - Sul の若手技術職員を招き、「水文トレーナー育成技術研修」受講生が講師となって、「IFAS モデル作成研修（1 日）」を実施した。

1) Mr. Ernesto Valente Tivane (DNGRH/DGBH)
2) Mr. Teodomiro da Silva Pedro Cabral (ARA-Sul)
3) Ms. Adalgisa Iracema Tinga (ARA-Sul)
4) Mr. Zacarias Vasco Cossa (ARA-Sul)

「水文トレーナー育成技術研修」受講生は、自らが「IFAS モデル作成研修（1 日）」の研修内容と研修スケジュールについて事前に議論・準備し、「IFAS モデル作成研修（1 日）」を効果的に開催した。

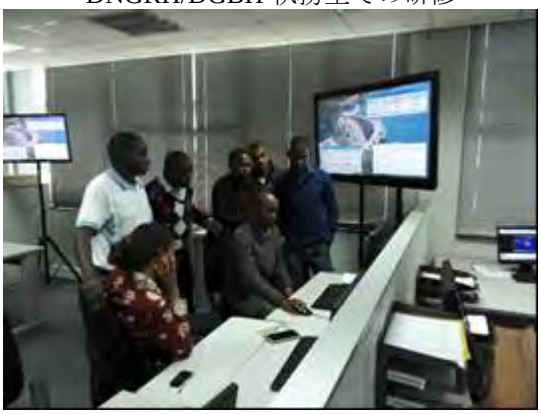
研修会場

研修会場

DNGRH/DGBH 執務室での研修

DNGRH/DGBH 執務室での研修

受講生による「IFAS モデル作成研修」指導



受講生による「IFAS モデル作成研修」指導

各受講生は積極的に研修に参加し、9 日間の研修日程を修了した。「水文トレーナー育成技術研修」を通じて、受講生は以下の技術的な内容を理解・習得した。

- 災害リスク管理に必要な水文学および水力学の基礎知識
- 水文観測の重要性とその精度管理
- H-Q 関係式の意味とその作成および利用方法
- IFAS モデルおよび AutoIFAS モデルの作成・同定手法
- IFAS モデルおよび AutoIFAS モデル作成の指導スキル
- GIS の利用などのモデル作成関連周辺技術
- 警報レベル定義の重要性
- AutoIFAS 洪水早期警戒システムの運用・管理方法

水文トレーナーの認証

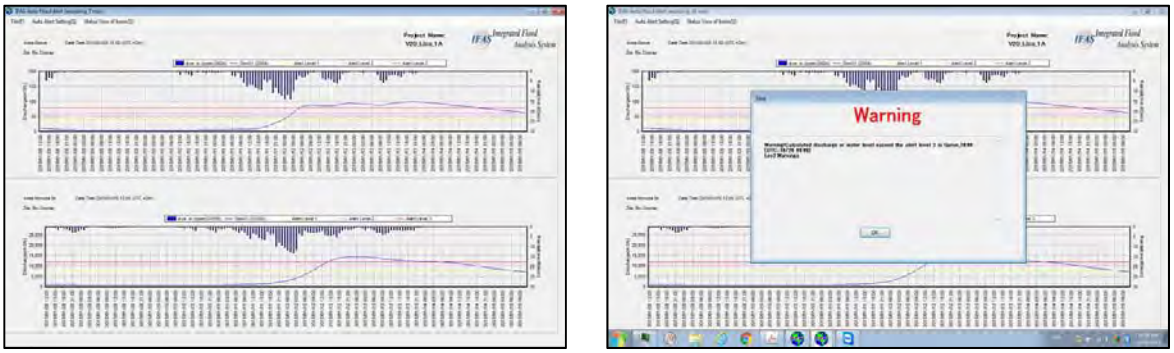
「水文トレーナー育成技術研修」期間中、およびその後の研修フォローアップ OJT における研修受講生の能力を総合的に評価し、DNGRH/DGBH の承認を得た後、以下の認証資格が候補者に授与された。授与された資格証明書を Appendix 6-2 に示す。

認証資格	対象者
• Hydrological & Hydraulic Trainer • IFAS & AutoIFAS Modeling Trainer	1) Mr. Agostinho Vilanculo 2) Mr. Jose Alvaro Malanco 3) Mr. Isac Filimone
• Assistant Hydrological & Hydraulic Trainer • IFAS & AutoIFAS Modeling Trainer	4) Mr. Armando Cuinhane 5) Ms. Filoca Fondo 6) Mr. Leno Gomes

(4)　洪水早期警報システム

AutoIFAS システム（IFAS シミュレーション結果と警報基準レベルに基づく自動洪水警報システム）の利用とその設置の是非について、JICA チームと DNGRH/DGBH 関係者で協議を重ねた。その結果、Licungo 川流域を対象とした AutoIFAS システムの試験運用の実施が決定された。

これまでの研修成果を活用し、DNGRH/DGBH 主導で Licungo 川流域を対象とした AutoIFAS システムを DNGRH/DGBH 内の PC に構築し、2016 年 11 月 29 日より試験運用を開始した。24 時間稼働の状況を確認しつつ、引き続きモデルのキャリブレーションを継続すると共に、システム再起動時の手順、計算水位と観測水位の簡易補正等の指導を継続的に実施した。



試験運用中の Licungo 川流域 AutoIFAS システム（出力イメージ）

Licungo 川流域 AutoIFAS システムの試験運用を通じて、DNGRH/DGBH は以下の課題解決の必要性を認識した。

- DNGRH ネットワークセキュリティーによる FTP 接続制限への対応
- 停電発生後の AutoIFAS システム再起動
- ネットワーク異常後の AutoIFAS システム確認
- 衛星降雨データ（GSMaP）自動ダウンロード状況の常時管理
- AutoIFAS システムの日常管理
- AutoIFAS システム出力の日常管理
- AutoIFAS システムの運用･管理責任者が明確でない

これらの課題を DNGRH/DGBH 関係者と JICA チームで再共有し、課題解決に向けた議論の場が持った。その結果、「水文トレーナー育成技術研修」の期間中、これらの課題解決と課題発生の未然防止を目的とした研修講義を組み込み、また、AutoIFAS システムの日常運用管理に係る OJT を実施した。

研修成果の最終確認として、DNGRH/DGBH 職員が Licungo 川流域の AutoIFAS の運用モデルを再構築し、試験運用状況を確認した。また、不測の事態に備えて河川管理技術担当専門家がリモート操作で試験運用 PC にアクセスできる環境を整備した。さらに、AutoIFAS 洪水早期警報システムの日々の管理と継続運用を確実なものとすることを目的に、DNGRH/DGBH 職員の中から“AutoIFAS Flood Early Warning System Manager”と“AutoIFAS Flood Early Warning System O/M Specialist”を選任した。

GSMaP（衛星観測降雨）データ（FTP サーバ）へのアクセスは、DNGRH/DGBH 事務所内の LAN セキュリティー設定のため、アクセスが制限されていた。事務所内 LAN 管理者の許可を得て、早期警報システム試験運用の PC 1 台が GSMaP データへのアクセスが可能となった。しかしながら他流域モデルの構築等のため、DNGRH/DGBH 内の他の PC も容易に GSMaP データへアクセスできる状況が望まれた。

LAN セキュリティーを確保した現実的な解決案とし、専門家からルーターの増設を提案した。DGBH は、これを必要と判断し、DGBH の独自予算で無線ルーターが増設された。（写真参照：AutoIFAS システム稼働状況）

2017 年 11 月現在、Licungo 川流域 AutoIFAS システムは、DNGRH/DGBH の管理の下、順調に稼働している。

DNGRH/DGBH 内の AutoIFAS システム
（2017 年 8 月 22 日現在）

(5) 衛星データの利活用

(i) 技術移転ワークショップの開催（リモートセンシング・雨量観測）

2015 年 11 月 26 日、Mocuba Unit で ARA-CN 職員（Mocuba Unit 等を含む）を対象に技術移転ワークショップを開催した。参加者は次の通りである。

Mr. Sergio Anela	Technician, ARA CN/UGBO Mocuba
Ms. Marilu Agostinho	ARA CN/UGBO Mocuba
Mr. Will Antonio Alfredo	Technician, ARA CN Nampula
Mr. Julio Lucas	Technician, ARA CN Nampula
Mr. Heminio Mario	Technician, ARA CN Namapa
Mr. Vasconcelos Lenque	Technician, ARA CN/UGBE Nacala
Mr. Luis Semo Mogeie	Technician, ARA CN/UGBO Gurue

リモートセンシング技術については、初歩段階として、以下の 4 項目に絞った技術移転を実施した。また、参加者との議論を通じて今後の取り組みの方向性を見出すことに重点を置いた。

- 衛星画像とは
- 衛星画像データのダウンロードおよび解析
- インターネット上で利用可能な降雨・洪水情報の活用
- 大規模災害時に緊急観測を行う国際的枠組みについて

これらは基本的に「降雨の把握」と「地表面状態（浸水域等）の把握」に関するリモートセンシング技術であるが、項目ごとに担当者が情報を得るまでのプロセスが異なる。参加者の意見としては、どれか一つの項目というより、これら 4 項目の全てが興味深いものであるとのことで、リモートセンシング技術全般への高い関心がうかがわれた。その一方で、「それらの技術を業務にどう活かせばよいのかわからない、画像の閲覧やデータのダウンロード、ソフウェアによる解析等を実技指導してほしい」等の意見も出された。

リモートセンシング技術は「情報を得る手段」であり、所属する部署や担当する業務の範囲によっても最適な技術は異なることが想定される。したがって、今回の技術移転ワークショップの結果と 2015 年 12 月 2 日に DNGRH で行った同様のワークショップの結果を踏まえ、次回以降は「誰が」「何に」使うのかという前提を明確にした上で、対象者を絞り短期集中型かつ実践的な指導を行うことが有効であると判断した。また同様に、異なる立場の人に向けた複数のコースを用意することも効果的であると考えられた。

本ワークショップにて使用したプレゼンテーション資料を Appendix 6-3 に示す。

(ii)　衛星データ利活用の紹介

2015 年 12 月 4 日のマネジメントコミッティーミーティングを「衛星データの利活用」についての意見聴取の機会と捉え、水管理に関する一般的なリモートセンシング技術の紹介を行った。紹介した内容は次の通り。

- 基本（雨量、土地被覆図、デジタル標高モデル）
- 陸水（流出予測、河川や流域のモニタリング、湖沼のモニタリング）
- 農業（雨量、土壌水分、干ばつ指数）
- 災害（豪雨アラート、浸水域抽出と災害チャータ、地滑り域の把握）

紹介したトピックが多岐にわたったこともあり、リモセン技術への期待とともに、それらを習得するためには十分な時間を充てる必要があるとの指摘があった。また、他の支援プログラムとの整合性を確保すべきとの意見も出された。

次のステップとして、具体的かつ実践的なリモセン技術の使い方のトレーニングを行ってほしいとの要望があった。また、その際には、例えば使用する雨量データの単位等、DNGRH や ARA で実施している業務の実態を考慮することも求められた。

これらの要望を踏まえて内容と方法を検討し、技術移転を実施することとした。内容は別途各担当職員と議論した結果を踏まえ、衛星雨量データの IFAS 以外での活用と、浸水域抽出を含む河川・流域の変化抽出の二点が有力な候補であると判断した。

その他、予測雨量データ入手の可能性や豪雨が地域社会に与えるインパクトのシミュレーションの実現性についても質問があった。これらはリモートセンシング技術のみでは実現できないものであるが、DNGRH 等がその利活用を実現を希望しているという点で、留意すべき事項である。

本ミーティングにて使用したプレゼンテーション資料を Appendix 6-3 に示す。

(iii)　水管理のためのリモートセンシング研修の実施

2016 年 11 月 21 日～12 月 2 日に DNGRH で、衛星データ利活用に関する技術移転を目的とした「水管理のためのリモートセンシング」研修を実施した。以下の DNGRH/DGBH の 8 名の職員が参加した。

Mr. Agostinho T. F. Vilanculos
Mr. Armando P. Cuinhane
Mr. José A. Malanço
Ms. Filoca A. Fondo
Mr. Leno Gomes
Mr. Herminio M. Manhiça
Mr. Omar S. Coiara
Ms. Arcina J. Nhavoto

研修は、極力多くの職員が参加できるよう、受講者の都合に応じて日毎に時間を定めて実施した。また 1 回当たりの研修時間は最大 2 時間程度とし、残りの時間を、受講者への個別の指導やその日に出た問題点の調査、研修資料の改訂や追加作成に充てた。個々の技術的な問題点については、それぞれ解決策を見出し、翌日の研修で受講者にフィードバックした。さらに、業務に成果を活かしやすくなるよう、実習には受講者が業務で使用しているコンピュータを用いた。

当初、「ArcGIS 上での GSMaP の利用」と「衛星データによる洪水マップの作成」という二つの実習のみの予定であったが、衛星リモートセンシングの基礎的・一般的な知識も得たいとの要望があったため、「水管理のためのリモートセンシングの基礎」をテーマとする講義を追加した。その結果、研修全体のプログラムは以下のようになった。

表 4-11　水管理のためのリモートセンシング研修　プログラム

Day	Date	Description
01	21 Nov. (Mon)	• Practice: How to Use GSMaP on ArcGIS - Download GSMaP and preparation to use
02	22 Nov. (Tue)	• Practice: How to Use GSMaP on ArcGIS - Extract African region
03	23 Nov. (Wed)	• Practice: How to Use GSMaP on ArcGIS - Calculate accumulated rainfall
04	24 Nov. (Thu)	• Practice: How to Use GSMaP on ArcGIS - Export the data
05	25 Nov. (Fri)	• Practice: How to Use GSMaP on ArcGIS - Self-practice, run through the procedure (1/2)
06	28 Nov. (Mon)	• Practice: How to Use GSMaP on ArcGIS - Self-practice, run through the procedure (2/2)
07	29 Nov. (Tue)	• Lecture: Basics of the Remote Sensing for Water Management (1/2) - Principle of Remote Sensing
08	30 Nov. (Wed)	• Practice: How to Make Flood Map Using Satellite Data - By ArcGIS - By Google Earth Engine

Day	Date	Description
09	1 Dec. (Thu)	• Lecture: Basics of the Remote Sensing for Water Management (2/2) - Remote sensing technology for water management - The first step of remote sensing for water management - Important points of applying GSMaP
10	2 Dec. (Fri)	• Q&A, Follow-up

テーマ 1：ArcGIS 上での GSMaP の利用（実習）

本業務で導入した IFAS/AutoIFAS は雨量データとして GSMaP を使用しているが、GSMaP の有効性は必ずしもこれに限ったものではない。そこで、DGBH の業務で多く使われている ArcGIS に GSMaP を取り込んで利用する手順を、実習を通して受講者に伝えた。

受講者が望む使い方に沿って実際に行ってみると、いくつかの技術的な問題点が生じたが、いずれもその解決策を見出すことができた。

研修の成果は、受講者が正しい解析手順を習得したことであり、今後は各人の業務の内容と目的に応じて、ArcGIS 上で GSMaP を利用することが可能となった。

テーマ 2：衛星データによる洪水マップの作成（実習）

雨量データ（GSMaP）の活用とは異なる衛星リモートセンシング技術の利活用として、衛星データから洪水マップを作成する方法について、実習による技術指導を実施した。解析に使用した衛星データは、ヨーロッパ宇宙機関（ESA）の Sentinel-1 衛星に搭載された合成開口レーダ（SAR）のデータである。

まず、衛星データから洪水域を抽出する手順を受講者が理解するために、従来の伝統的な方法に沿った説明を行った。これは洪水前・後の衛星データを検索し、ダウンロードして ArcGIS に取り込んで処理を行うものである。次に、現時点で最も先進的と思われる、Google Earth Engine による解析手法を実習指導した。この方法では、対象とする場所と時期をウェブブラウザ上で指定するだけで、Google 側のコンピュータで全ての処理が行われて結果が表示される。

受講者は、洪水域を抽出する仕組みを理解し、Google Earth Engine の利用した洪水マップの作成方法を習得した。Google Earth Engine を利用するスクリプトはユーザが自由に作成することができ、今後さまざまな応用を図ることも可能である。

テーマ 3：水管理のためのリモートセンシングの基礎（講義）

前述のように、受講者の要望に応えて追加した講義テーマである。実習による能力の向上と対をなす、講義による知識の習得を目的に、以下の 4 項目の講義を実施した。

a) リモートセンシングの基礎
b) 水管理のためのリモートセンシング技術
c) 水管理のためのリモートセンシング初歩
d) GSMaP 利用上の注意

このうち a) は 2015 年 10 月の日本での招聘研修における講義、b) は 2015 年 12 月のマネ

ジメントコミッティーミーティングでの発表、c) は 2015 年 11 月のモクバ及びマプトでのセミナーをそれぞれ基にしている。

講義では多くの質問もあり、講義の成果として、受講者は GSMaP やレーダデータを含む衛星による観測の概要を理解した。また、受講者からは、業務との関連において、衛星リモートセンシングによる土壌水分や旱魃指数の情報にも強い関心が示された。

研修全体について

受講者は通常業務を抱えており、また出席すべき会議も多く、全員が多忙な状況であるため、研修の時間に受講者の全員が揃うことは稀であった。さらに、組織における受講者各人の役割や担当分野、持っている知識や能力にも幅がある。こうしたことから、個々の受講者としては研修の全ての内容を理解・習得したとはいえないが、各受講者が互いに得た知識と能力を補完し合いながらDGBHとしてリモートセンシング技術を活用できる十分な水準に達したと判断できる。

研修最終日に DGBH の Rute 部長に研修の内容と成果について報告した。部長からは、特に各テーマについて今後中心となり得る人物について質問があり、実施した研修に対する理解と感謝の意が示された。

今後の受講者の便宜のために、全ての研修資料、衛星データ、補助データ、作成したスクリプトや処理結果、参考文献等を DNGRH イントラネット上の共有フォルダに整備して周知した。DNGRH の職員であれば誰でもこれら資料を利用することが可能である。

本研修にて使用した説明資料を Appendix 6-3 に示す。

4.11 セミナー・ワークショップ、マネジメントコミッティーの開催

本業務で実施した水関連災害リスク管理に関するセミナー・ワークショップの一覧を表 4-12 に示す。

表 4-12　セミナー・ワークショップの一覧

実施日	場所	内容
2015 年 2 月 6 日	マプト	Licungo 川洪水の現地調査報告
2015 年 2 月 19 日	マプト	技術勢セミナー／ 第 1 回マネジメントコミッティーミーティング - ポスト HFA（Zero-Draft）の概要 - HFA ならびにポスト HFA に対する JICA の貢献
2015 年 2 月 26 日	マプト	ラップアップミーティング - Licungo 川洪水の第 2 回現地調査報告 - 洪水氾濫解析
2015 年 5 月 27 日	ナンプラ	河川管理に関するセミナー
2015 年 6 月 12 日	マプト	河川管理ならびに仙台防災枠組に関するセミナー
2015 年 8 月 8 日 ～21 日	マプト	洪水解析モデルに関する技術研修
2015 年 8 月 26 日	モクバ	ワークショップ

		- Licungo 川の河川管理 - 理解しやすい災害情報
2015 年 8 月 27 日 ～9 月 10 日	ナンプラ	洪水解析モデルに関する技術研修
2015 年 9 月 15 日	マプト	ワークショップ - IWRM、IFM を通じた洪水防御・軽減の強化 - 理解しやすい災害情報
2015 年 11 月 26 日	モクバ	リモートセンシングならびに雨量観測に関するセミナー
2015 年 12 月 4 日	マプト	リモートセンシング、早期警報システム、雨量観測に関するセミナー
2016 年 1 月 29 日	ナンプラ	警報文の伝達に関するワークショップ
2016 年 2 月 4 日	マプト	洪水時の緊急対応と警報文の改善に関するワークショップ
2016 年 5 月 24 日 ～6 月 3 日	モクバ	河川管理施設台帳、河川管理計画に関する研修
2016 年 6 月 6 日 ～22 日	ナンプラ	洪水リスク管理計画、河川管理に関する研修
2016 年 10 月 6 日 2016 年 10 月 10 日	ナンプラ マプト	ワークショップ - 河川管理に関する研修計画 - 洪水対策事業の経済評価 - タイムライン - 日本の洪水被害
2016 年 10 月 17 日 ～28 日	マプト	洪水早期警報システムに関する研修
2016 年 11 月 7 日 ～8 日	マプト	洪水早期警報システムに関する研修
2016 年 11 月 21 日 ～12 月 2 日	マプト	衛星技術を活用した降雨と浸水域ならびにリモートセンシングに関する研修
2017 年 8 月 8 日 ～18 日	マプト	水文水理、河川モデルに関するトレーナー研修

ワークプランや報告書の提出に合わせて、マネジメントコミッティーミーティングを 3 回開催した。各回の時期や内容を表 4-13 に示す。

表 4-13　マネジメントコミッティーミーティング

回	開催日	内容
第 1 回	2015 年 2 月 19 日	ワークプランの説明、協議
第 2 回	2015 年 12 月 4 日	業務進捗報告書の説明、協議
第 3 回	2017 年 12 月 8 日	業務完了報告書（ドラフト）の説明、協議

4.12 C/P 招聘にかかる業務

本業務では、C/P の本邦招聘を 2015 年 3 月と同年 10 月の 2 回実施した。それぞれの詳細については、本章の 4.5 項と 4.7 項に記載したとおりである。

表 4-14　本邦招聘

実施時期	招聘の目的	参加人数
2015 年 3 月	第 3 回国連防災世界会議への参加	6 名
2015 年 10 月	日本における総合的な河川管理の視察	4 名

4.13 機材調達

現地作業に必要となる機材を本邦または現地にて調達した。機材の仕様については C/P との議論の上決定し、下表のものを調達した。

表 4-15　調達機材

品名	仕様	設置場所
コンピュータ-1	・ ノートパソコン HP Probook 450 Ci7 8GB 1 TB, Windows 7/8 Pro ・ Office Home & Business 2013, ・ Kaspersky 2015 Antivirus ・ Mouse Verbatim Go Nano Wireless Blue ・ Mala Targus Back Pack ・ HDD Externo 1TB WD 2.5” Elements USB 3.0 Black	DNGRH
コンピュータ-2	・ ノートパソコン Toshiba Tecra Z50-A0445, Ci7 8GB, 500 GB, Windows 7 Pro ・ Office Professional 2013 ・ Kaspersky 2015 Security ・ HDD Externo 1TB WD 2.5” ・ Mouse NGS Roly wireless ・ Mala NGS 15” Black Organizer	ARA-CN
プリンタ	・ Fotocopiadora Color Konica Minolta Bizeub-C224e ・ Toner TN-321 K(4), Y(2), M(2), Y(2) ・ Cabos de Alimentacao ・ Alimentador Duplex DF-624	ARA-CN
プロジェクター	・ EPSON EB-7116W	DNGRH
DEM データ	・ ALOS, Global Digital 3D-5m, On-Demand Level2, Mozambique ・ ALOS, Global Digital 3D-2.5m, On-Demand PRISM Panchromatic Ortho	DNGRH

第５章　提言

5.1　提言

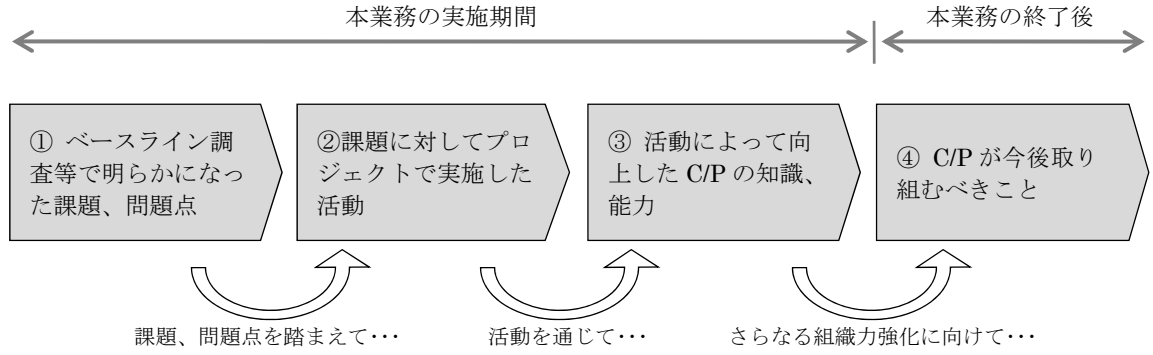
本業務では 3 年を超える実施期間のあいだに水関連災害リスク管理に関して様々な活動を実施してきた。これらの活動は以下の 7 つの分野に分けることができる。

A. 水文観測／水文データ
B. 河川および河川流域の特性
C. 構造物対策
D. 洪水早期警戒システム（非構造物対策）
E. わかりやすい災害情報（非構造物対策）
F. 河川管理施設台帳
G. 人材育成と組織開発

本業務の開始時に洪水リスク管理にかかる現状と課題を把握するためにワークショップや聞き取り調査などによるベースライン調査を実施した（4.4 項に詳述）。そこで明らかになった課題、問題点を踏まえて様々な活動内容を検討し実施した。

これらの活動を通じて C/P は洪水リスク管理に係る知識や技術を身につけることができたが、本業務が終了した後も継続して能力強化を図っていかなければならない。

上述の A～G の分野ごとに、① 業務開始時のベースライン調査等を通じて明らかになった C/P の課題・問題点、② 課題・問題点に関してプロジェクトで実施した活動、③ 活動を通じて向上した C/P の能力・技術、④ プロジェクト終了後に C/P が取り組むべきこと、を表 5-1 に取り纏めた。



5.2　アクションプラン

前項で整理したプロジェクト終了後に C/P が取り組むべき項目について、優先度と必要な期間を考慮し図 5-1 に示すアクションプランを作成した。アクションプランは 2018 年を開始年とし、終了年を仙台防災枠組の目標年に合わせて 2030 年とした。なお、各活動を実施するために追加的に費用が生じる項目について、JICA チームと C/P が協力して概略コストを見積もった。見積算定資料を参考として図 5-1 のあとに示す。

表 5-1　課題・問題点～プロジェクト活動内容～向上した知識・能力～今後の課題

❶ ベースライン調査等で明らかになった課題、問題点 ⇨	❷ 課題に対してプロジェクトで実施した活動 ⇨	❸ 活動によって向上した C/P の知識、能力 ⇨	❹ C/P が今後取り組むべきこと
水文観測／水文データ			
水文データが整理されていない。 複数のデータベースが混在している。 データベースのライセンス更新のための予算がない。	観測所マップの作成、観測データ一覧の作成	観測所ごとのデータ保有期間が明確になった。 観測データの連続性の途絶、観測所の疎な分布、近年のデータ入力が滞っている、などの問題を理解した。	・ 無料ライセンスの水文データベースを構築する。 ・ 複数の既存データベースのデータを上記に統合する。 ・ INAM など他機関が観測している水文データについても上記データベースに統合し、共有できる体制を構築する。
雨量計測ますが雨量計の大きさと一致していない観測所が確認された。	セミナーの場で問題を明らかにした。 その後 DNGRH が主導で各 ARA に調査させた。	何かのタイミングで不適切な機器または使用方法になっている可能性があることを理解した。	・ 全ての観測所を対象に水文観測方法、機器について点検
流域に比べて雨量観測所数が少ない。洪水時にリアルタイムでデータを入手できる観測所はさらに限られる。	衛星観測データの利活用に関する指導（GSMaP、GFAS、Flood Map、地形データ等）を行った。	衛星観測データの利用について様々なフリーツールがあることを理解し、それらの操作を学んだ。 流出モデル（IFAS）研修では任意の時点の降雨を用いて流出解析ができるようになった。また、予警報モデル（Auto-IFAS）研修では準リアルタイムの観測雨量を用いて流出解析ができるようになった。	・ GSMaP、GFAS はウェブサイトで簡単に雨量や確率規模を見ることができる。使い続けること、雨の分布や雨域の移動方向などを観察して降雨の理解を深める。また、自分の場所と示される雨量を比べて、その精度 or 誤差の感覚を身につける。
DNGRH、ARA の職員が、住民に委託して観測している水文データの精度を信じていない。	DNGRH に保管されていた『絵で見る水文観測（ポルトガル語版）』を Mocuba Unit に紹介、提供した。	イラストを多用した分かり易いハンドブックにより観測のポイントを理解した。	・ 観測を委託している住民に対して水文データの重要性を理解させるとともに観測方法を指導する。
HQ カーブが更新されていないためデータの信頼性が低い。	HQ カーブに関する指導を行った。 また、HQ カーブ作成に必要となる河道横断について、その測量方法を実地指導した。	現状の河道形状に応じた HQ カーブを使用しないと正しい流量が得られないことを学んだ。また、そのためには定期的な河川横断測量が必要なことを理解した。 簡易な横断測量の方法を実地訓練により習得した。	・ HQ カーブを総点検する。 ・ 定期的に横断測量を実施する。 ・ 流量観測時に観測値（水位、流量）と HQ カーブとの乖離具合を検証し、河道横断の変化を確認する。
過去の観測データに異常値が散見される。	手描きによるハイエトハイドログラフの作成を指導した。	観測値を図化していくことで異常値を発見することを学んだ。	・ 観測値を得たら、前時点の値やこれまでの傾向から、おかしな値でないか確認する癖をつける（左の図化はひとつの方法）。
洪水リスク管理計画			
河川・流域の理解	衛星画像（Google Earth）から河道、流域の特徴を把握する。	Google Earth から川・流域の特徴を判読することを学んだ。 ・ 流域の縦断面図、地形勾配、砂丘、蛇行河川、岩河床、微高地の集落と氾濫域の関係、氾濫形態の違い等	・ 衛星画像、地形図、現地にて河川、流域をよく観察して考察することにより、河川、流域の理解を深める。
任意地点にダムを設置した場合の貯水容量の算出方法を教えてほしい（ARA-CN の DG からの要望）	GIS とエクセルを用いた算定方法を指導した。 ①GIS を用いてコンターから標高ごとの面積を算出、②エクセルで標高と貯水量の関係を算出。	GIS とエクセルを用いて任意のダム地点における標高～貯水容量の関係を算定することができるようになった。	
構造物対策に関する技術力が低い	洪水リスク管理計画の策定のなかで構造物対策を検討した。	各構造物のもつ機能を理解し、それに応じた施設配置ができるようになった。	・ 今回は特定箇所において検討した。ほかの場所、河川や異なる洪水規模を対象に様々な検討を行い継続して実践力をつける必要がある。 ・ 将来的に、施設整備による効果を氾濫解析や経済分析などで評価できるようにする。
洪水予警報システム			
警報から水位上昇までの時間が短く、避難が間に合わない。	早期警報システム（Auto-IFAS）を指導した。	IFAS/Auto-IFAS モデルの作成技術を身につけた。	・ 雨期、特に洪水時における 24 時間運用体制を構築する。
		（衛星による）観測雨量を用いて水位を予測することができるようになった。 それにより以前より早い段階で警報を発することができるよ	・ 24 時間監視ができる体制を整える ・ Mocuba での水位観測頻度を高める。 ・ 記録を残して洪水後/雨期後にレビューし、警報発出のタイ

❶ ベースライン調査等で明らかになった課題、問題点 ⇨	❷ 課題に対してプロジェクトで実施した活動 ⇨	❸ 活動によって向上した C/P の知識、能力 ⇨	❹ C/P が今後取り組むべきこと
		うになった。	ミングや警戒水位等の見直しを検討する。
	水文トレーナーを育成した。	水文トレーナーとしてモデル作成を指導できる力を身につけた。	・ 水文トレーナーが講師となり、DNGRH や ARAs の職員に水文水理、河川工学の研修を実施し、組織の基礎技術力の向上を図る。
	Mocuba Unit での対応を検討、指導した。	Auto-IFAS の運用について： DNGRH への観測データの通知、DNGRH からの予測値に応じた警報の発出等の手順を理解した。 これらの検討を通じて予警報システムの概要、降雨と流量（水位）のピーク差、衛星降雨の時差などを理解した。	・ 雨期、特に洪水時の水位観測の頻度を上げる。18 時以降の観測。毎時観測を目指す。 ・ 特に Mocuba Unit では Auto-IFAS を過信することなく常に自ら情報収集と観測を怠らないようにする。
分かりやすい災害情報			
洪水時に必要な情報が住民に届いていない。	各組織が発出する災害情報を理解しやすい内容にするよう事例を示して提案した。	どのような文面が理解しやすいかを理解した。 ・過去の大きな洪水との比較 ・短く具体的なタイトル ・他組織や人に対して取るべき行動の助言	・ 洪水後にレビューして、必要に応じて改善する。
雨期に毎日配信している「Bulletin of National Hydrology」のハイエトハイドログラフが分かりづらい。	水位ハイドログラフが当該雨期の水位の他に前年、前前年の 3 本が描かれていた。前前年の表示をやめて既往最高水位発生年の水位を載せるよう提言した。	提言を受けて、Bulletin の表示を変更した。また、あらたに導入した水文データモニター画面も同様の表示とした。	・
河川管理施設台帳			
河川構造物の点検、維持管理が不十分なため、頻繁に被災している。	河川管理施設の維持管理のために河川施設管理台帳の作成を指導した。	各施設の現状調査における議論を通じて、求められる機能や被災原因等を学んだ。 洪水時にその機能を発揮するためには平常時の点検、維持管理が重要であることを理解した。 Google Earth をベースに維持管理台帳マップを作成できるようになった。	・ 台帳を整備し、継続的に更新していく。 ・ 台帳を活用して修繕の優先度を決める。 ・ 課題：インターネット接続環境
組織体制／人材育成			
DNGRH では洪水に係る業務の担当が水資源課や国際河川課などに分散している。	洪水リスク管理業務を担当する部署を独立させることを提言した。	流域管理部（その下に計画課と情報管理課）を新たに設置した。	・ 新設された流域管理部の技術力向上、人員確保、業務の充実を図り、組織力を向上させる。 ・ 維持管理を統轄する部署を設けて、ARAs が実施する維持管理を主導するとともに、河川空間管理や利水権の管理を行う。
DNGRH が実施している研修は、上下水が主で洪水リスク管理は含まれていない。	河川行政、統合洪水リスク管理、水文トレーナー（IFAS/）に関する研修プログラム、シラバスを作成した。	洪水リスク管理に係る能力を向上させるために必要な研修プログラム、シラバスを獲得した。	・ DNGRH 全体の研修計画に作成した研修計画を組み入れる。
すべての研修はドナーの資金援助に頼っている。			・ 研修の中身をドナー任せにせず、本業務で提案した研修計画を DNGRH が主導して実施する。

活動	技術支援の必要性	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A　水文観測／水文データ														
A1 水文データベースを構築する。 - 無料ライセンスを基本とした水文データベースを設計する。 - 既存の複数のデータベースに保管されているデータを新しいデータベースに統合する。 - INAMやMINAGなど他機関が保有するデータを本データベースに統合し、関係機関間で共有できる体制を構築する。	必要													
A2 全ての観測所を対象に水文観測の方法、機器を点検する。														
A3 H-Qカーブを更新する。														
(1) 現在使用しているH-Qカーブの作成年、河川横断の変化の状況を確認する／水文観測施設の現状を確認する。														
(2) 河川横断測量を実施する。														
(3) 定期的に流量観測を行うとともに出水時の観測も行う。														
(4) 高い水位を含めたH-Qカーブを作成する。														
A4 水文観測を委託している住民に対して水文データの重要性を理解させるとともに観測方法を指導する。														
A5 水文観測のテレメータ化を進める。（現在、リンポポ川流域、ザンベジ川流域の一部に導入中）	必要													
A6 ウェブサイトから降雨の分布や洪水の確率規模などを確認することができるGSMaPやGFASを継続して利用し、降雨に関する理解を深める。														
A7 流量観測値を得られたら、前回観測時の値やこれまでの傾向、H-Qカーブとの整合、などと比較してその妥当性を確認する習慣をつける。														
B　河川および河川流域の特性														
B1 衛星画像、地形図、現地にて河川、流域をよく観察して考察することにより、河川、流域の理解を深める。														
C　構造物対策														
C1 パイロットサイト以外の場所、河川や異なる洪水規模を対象に洪水リスク管理計画を検討、策定する。必要に応じて研修を実施し、継続して実践力をつける。	必要													
D　洪水早期警戒システム（非構造物対策）														
D1 観測データ、シミュレーション結果、警報発出などの記録を保管する。／洪水後に警報発出のタイミングや警報レベルなどをレビューし必要に応じて見直す。														
D2 水位予測の精度をあげるため、モクバ橋での水位観測を毎時観測にする。														
D3 出水時における洪水早期警戒システムの24時間運用体制を構築する。														
D4 水文トレーナーによる水文、水理、河川工学の研修を実施し、基礎技術力の向上を図る。														
D5 上記の研修を通して、他河川の洪水早期警戒システムを構築する。														
E　わかりやすい災害情報（非構造物対策）														
E1 洪水後に災害情報の伝達や住民の行動などをレビューし、必要に応じて情報の伝え方などを見直す。														
F　河川管理施設台帳														
F1 台帳を整備し、継続的に更新する。														
F2 台帳を活用して点検、早期修繕といった維持管理を実施する。														
G　人材育成と組織開発														
G1 新設された洪水・干ばつユニットの技術力向上、人員確保、業務の充実を図り、洪水リスク管理に係る組織力を向上させる。	必要													
G2 維持管理を統轄する部署を設けて、ARAsが実施する維持管理を主導するとともに、河川空間管理や利水権の管理を行う。														
G3 DNGRH全体の研修計画に本業務で作成した洪水リスク管理に関する研修計画を組み入れる。														

図 5-1　アクションプラン

Cost Estimation for Action Plan

1. Hydrological Observation / Hydrological Database

1-1 To establish an integrated hydrological Database

(1) To design a new integrated hydrological database without license renewal of software
(2) To integrate the existing database into the new database
(3) To establish a system that enables to share data with other organizations (INAM, MINAG, etc.)

Although DNGRH has some hydrological databases, those databases are not managed in a unified manner. It is desirable that an integrated hydrological database be established as a basic resource for water resource management, flood management, river management, etc.

[Condition of cost estimate]

- This activity is being implemented by DNGRH with financial support by the World Bank. No additional cost required.

1-2 To inspect actual hydrological observation activities and observation apparatus/ facilities

Hydrological observations by residents (readers) are performed upon the entrustment of ARAs at major points throughout the country. This activity covers inspection and guidance of actual hydrological observation activities by the readers, and inspection of equipment and facilities.

[Condition of cost estimate]

- Actual observation activities, equipment and facilities for hydrological observation shall be inspected/guided by a team of two ARA staffs in each ARA.
- Number of stations to be checked: 1,348 rainfall stations and 620 water level stations including 418 discharge measurement stations.
- It is assumed that five stations are inspected each day on average.
- It is assumed that the distance of the travel to inspect five stations is 80km each day on average.
- It is assumed that the fuel efficiency of the car is 7 km / liter.

Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
		Qty	Unit		
(1) Site allowance of ARAs' staff	1,700	787	person-day	1,337,900	1,968 stations/ 5 x 2 persons =787 person-day
(2) Fuel of vehicles	70	4,503	liter	315,210	80km/ 7km x 394 days =4,503 liter
Total				1,653,110	

1-3 To revise H-Q curve

In order to conduct reliable flood forecast, it is essential to create and update the H-Q relation curve at the water level observation point.

[Condition of cost estimate]

- To clarify the years of establishing H-Q curve and cross-section survey, existing condition of cross-section, etc. and hydrological station necessary to revise H-Q curve
- To conduct cross-section survey: 1 time/year x 12 major rivers with 200m river width on average.
- To conduct discharge observation during rainy season by using floats: 2 days/ section x 12 major rivers

- To make H-Q curve with high water range: 2 person-day/section x 12 major rivers

Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
		Qty	Unit		
(1) Clarification of existing HQ curves					No cost required.
(2) Cross-section survey	120,000	12	cross-sections	1,440,000	By contract with a surveying company. Width: 200m
(3) Discharge observation by ARAs					No cost required.
(4) Making H-Q curves by DNGRH					No cost required.
Total				1,440,000	

1-4 To instruct importance and a way of hydrological observation to resident in charge

Education of observers is indispensable to obtain sustainably reliable hydrological observation data.

[Condition of cost estimate]

- Guidance to observers (readers) is done by ARAs' staff with two person teams.
- Inviting nearby observers and conduct group trainings: 150 sites
- Organizing trains at two venues a day.
- It is assumed that the distance of the travel to two training venues is 80km each day on average.
- It is assumed that the fuel efficiency of the car is 7 km / liter.

Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
		Qty	Unit		
(1) Site allowance for ARAs' staff	1,700	150	person-day	255,000	150 sites/ 2 sites x 2 persons = 150 person-day
(2) Fuel cost	70	857	liter	59,990	150 sites/ 2 sites x 80km/ 7km/l = 857 liter
(3) Photocopy of training materials	5	4,772	pages	23,860	2,286 stations x 2 pages = 4,772 pages
Total				338,850	

1-5 To expand hydrological telemetry system (Existing systems are in Limpopo River and Zambezi River basins)

At present, hydrological observations by observers are conducted at 6:00, 9:00, 12:00, 15:00, 18:00 even during time of flooding. It is not possible to respond to heavy rain at night. For important rivers, it is important to construct a remote observation system every hour.

*DNGRH already has hydrological telemetry system in Limpopo and Zambezi River basins. Please refer to the cost of the existing systems.

1-6 To continue to utilize GSMaP or GFAS which provide rainfall distribution or flood probability on the web-site in order to deepen the understanding of rainfall features.

Engineers and technicians of DNGRH and ARAs should deepen their understanding on the rainfall characteristics and flooding of the area in charge. Therefore, they should put in the habit of utilizing GSMaP and GFAS which can be used free of charge on the web.

* No cost incurred.

1-7 To check the observed data comparing with the last data or the trend, or evaluate deviation from H-Q curve as a habit

It is important for the engineers and technicians of DNGRH and ARAs to compare the hydrological observation data with the H-Q relation curve to evaluate the divergence in order to improve the accuracy of the H-Q relation curve.

* It is a task to be carried out as a routine and no special expenses will be incurred.

2. Water Related Disaster Risk Management Plan

2-1 To observe satellite image, topography map, river basin on site in detail and to deepen understandings of river and river basin

In order to develop the capacity of engineers and technicians of ARAs for water-related disaster risk management, the training for utilization of satellite images, topographical maps and study tour of river basins to deepen the understanding on rivers should be implemented by the trainers of DNGRH.

[Condition of cost estimate]

- Trainers of DNGRH conduct technical training to deepen the understanding of river basin for ARAs' technical staff.
- Duration of training: Lecture 3 days, Field trip 2 days
- Two DNGRH Trainers visit ARAs' office and provide technical guidance and field investigation.
- Number of ARAs: 5 ARAs
- Train for 2 ARAs every year.
- Training venues are ARAs' facilities. Vehicles for site visits are ARAs' vehicles.
- It is assumed that the distance of the site visit is 80km on average.
- It is assumed that the fuel efficiency of the car is 7 km / liter.

Item		Unit Price (MT)	Quantity		Amount (MT)	Remarks
			Qty	Unit		
(1)	Allowance for DNGRH trainers	2,500	60	days	150,000	6 days x 2persons x 5 ARAs= 60 days
(2)	Accommodation for DNGRH trainers	5,000	40	nights	200,000	5 nights x 2 persons x 4 ARAs = 40 nights
(3)	Fuel for field trip	70	114	liter	7,980	80km / 7km x 2days x 5 ARAs= 114 liter
(4)	Air fare (Maputo-Beira)	22,000	2	persons	44,000	Economy class, round trip, for DNGRH trainers
	Air fare (Maputo-Tete)	27,000	2	persons	54,000	- ditto -
	Air fare (Maputo-Nampula)	40,000	2	persons	80,000	- ditto -
	Air fare (Maputo-Pemba)	36,000	2	persons	72,000	- ditto -

2-2 To conduct relevant trainings on study of water related disaster management plan for other rivers with different flood scales

It is necessary to support staff of DNGRH to elaborate water-related disaster management plan for other important river basins with different flood scales.

[Condition of cost estimate]

- It is assumed to be conducted by the consulting experts as the technical assistance to the DNGRH staff
- Period of the technical assistance: 3 years
- Input of foreign experts: 30 person-months in total

Item	Unit Price (USD)	Quantity		Amount (USD)	Remarks
		Qty	Unit		
(1) Remuneration					
• River planning expert	20,000	10	person-month	200,000	
• River management expert/ Hydrologist	20,000	8.5	person-month	170,000	
• Institutional development expert	20,000	6	person-month	120,000	
• Environmental expert	20,000	5.5	person-month	110,000	
(2) Travel expense		1	lump sum	290,000	
(3) Direct expenses		1	lump sum	110,000	
Total				1,000,000	

3. Flood Early Warning System

3-1 To keep the records of observed data, simulation result, alert message, etc. and to review timing of alert issue, alert level, etc. after every

In order to improve accuracy of the flood early warning, it is indispensable to keep the records of observed data, simulation result, alert message, etc. and to review the timing, level, etc., based on the records. These activities should be conducted as one of the routine/responsible works of DNGRH.

* There are no special cost for these activities.

3-2 To conduct hourly water level observation at Mocuba bridge in order to improve the simulation accuracy

In order to improve the accuracy of simulation by IFAS/Auto-IFAS, it is effective and important to calibrate the simulation based on the hourly water level records of floods.

- It is assumed that the hourly water level observation during floods are conducted by the staff of Mocuba Unit of ARA-CN.
- It is assumed that duration of a flood is two days and two floods in a year are observed.
- It is assumed that observation of a flood is conducted by three staffs with 3 shifts a day.

Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
		Qty	Unit		
(1) Site allowance for observer of ARA-CN	3,000	4	person-nights	12,000	1 persons x 2 nights x 2 times a year = 4 person-nights
staff at Mocuba bridge					
Total				12,000	

3-3 To establish 24-hour operation system during flood

At present, there are no water level observation during 18:00 to 6:00. However, there is a possible flood during this period. In case of a possibility of flood occurrence during this period based on tendency of water level and whether forecast by INAM, it is important to be put on full alert on 24 hour schedule and to observe water level continuously.

[Condition of cost estimate]

- It is assumed that DNGRH establishes the act or ordinance which stipulates the emergency operation on 24 hour schedule as a official duty of ARAs when a flood will occur.
- It is assumed that DNGRH gives a order to all ARAs.
- ∗ No particular expenses will occur.

3-4 To conduct training for ARAs' staff on hydrology, hydraulics, river engineering by Auto-IFAS trainers in order to improve the basic engineering capability

In order to enhance the knowledge about hydrology, hydraulics and river engineering, the trainers of DNGRH conduct the technical trainings for ARAs' staff.

[Condition of cost estimate]

- It is assumed that trainers of DNGRH in a team of 2 staffs conduct technical guidance and field inspection in respective ARAs.
- Numbers of ARSs: Five ARAs
- Duration of training: 5 days (6 days including travel day)
- It is assumed that the trainings are conducted in two ARAs by use of ARAs facility every year.

Item		Unit Price (MT)	Quantity		Amount (MT)	Remarks
			Qty	Unit		
(1)	Site allowance for DNGRH trainer	2,500	60	days	150,000	6 days x 2persons x 5 ARAs= 60 days
(2)	Accommodation for DNGRH trainer	5,000	40	nights	200,000	5 nights x 2 persons x 4 ARAs = 40 nights
(3)	Photocopy of training materials	5	1,000	pages	5,000	5 ARAs x 5 staffs x 40 pages = 1,000 pages
(4)	Air fare (Maputo-Beira)	22,000	2	persons	44,000	Economy class, round trip, for DNGRH trainers
	Air fare (Maputo-Tete)	27,000	2	persons	54,000	- ditto -
	Air fare (Maputo-Nampula)	40,000	2	persons	80,000	- ditto -
	Air fare (Maputo-Pemba)	36,000	2	persons	72,000	- ditto -
Total					605,000	

3-5 To build the flood early warning system in other rivers through the above trainings

Through the above trainings, flood early waring systems in other major rivers are established.

[Condition of cost estimate]

- It is assumed that the trainers of DNGRH conduct establishment of the system and guidance on calibration of the system to respective ARAs.
- It is assumed that the systems are established in two ARAs every year.

- Numbers of ARSs: Five ARAs
- Duration of work: 5 days (6 days including travel day)
- It is assumed that existing PC and network connection in each ARA can be appropriate to the system.

	Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
			Qty	Unit		
(1)	Site allowance for DNGRH trainer	2,500	60	days	150,000	6 days x 2persons x 5 ARAs= 60 days
(2)	Accommodation for DNGRH trainer	5,000	40	nights	200,000	5 nights x 2 persons x 4 ARAs = 40 nights
(3)	Air fare (Maputo-Beira)	22,000	2	persons	44,000	Economy class, round trip, for DNGRH trainers
	Air fare (Maputo-Tete)	27,000	2	persons	54,000	- ditto -
	Air fare (Maputo-Nampula)	40,000	2	persons	80,000	- ditto -
	Air fare (Maputo-Pemba)	36,000	2	persons	72,000	- ditto -
	Total				600,000	

4. Easily Understandable Disaster Information

4-1 To improve the disaster information by reviewing it after flood

Although the flood early warning system is established, it will not lead to voluntary evacuation of residents without easily understandable warning message. It is important for respective ARAs to improve the warning message based on the review of issued information after flood.

[Condition of cost estimate]

- ARAs have the interview survey with related authorities and the leaders of community disaster prevention committees which receive the alarm
- Interview survey is conducted by respective ARAs' staffs with a team of 2 staffs
- It is assumed that the travel distance for the survey is 80km on average.
- It is assumed that the fuel efficiency of vehicle is 7 km/l
- Based on the result of interview survey, ARAs improve timing and contents of alarm messages.

	Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
			Qty	Unit		
(1)	Site allowance ARAs' staff	1,700	10	person-days	17000	2 staff x 5 days = 10 person-days
(2)	Fuel of vehicle	70	57	liter	3990	80km/ 7km x 5 days = 57 liter
	Total				20990	

5. Inventory of River Management Structures

5-1 To prepare the inventory for all structures and to continue update

It is important for ARAs to grasp the present condition of all structures and to operate and maintain those structures properly. As basic material of operation and maintenance activities, respective ARA make the inventory of all structures in their jurisdictional areas.

[Condition of cost estimate]

- The trainers of DNGRH conduct trainings of inventory of structures to ARAs' staff.
- Trainings are conducted by a team of 2 trainers of DNGRH.
- Duration of training: Lecture: 5 days, Field training: 5 days
- It is assumed that the distance of the field training is 80km per day.
- It is assumed that the fuel efficiency of the car is 7 km / liter.
- Inventory survey of all structures of respective ARAs is conducted as a routine works of ARAs, and no particular expenses occur.

Item		Unit Price (MT)	Quantity		Amount (MT)	Remarks
			Qty	Unit		
(1)	Site allowance for DNGRH trainer	2,500	110	days	275,000	11 days x 2persons x 5 ARAs= 110 days
(2)	Accommodation for DNGRH trainer	5,000	80	nights	400,000	10 nights x 2 persons x 4 ARAs = 80 nights
(3)	Photocopy of training materials	5	1,000	pages	5,000	5 ARAs x 5 staffs x 40 pages = 1,000 pages
(4)	Air fare (Maputo-Beira)	22,000	2	persons	44,000	Economy class, round trip, for DNGRH trainers
	Air fare (Maputo-Tete)	27,000	2	persons	54,000	- ditto -
	Air fare (Maputo-Nampula)	40,000	2	persons	80,000	- ditto -
	Air fare (Maputo-Pemba)	36,000	2	persons	72,000	- ditto -
(5)	Fuel of vehicle	70	57	liter	3,990	80km/ 7km x 5 days = 57 liter
Total					933,990	

5-2 To conduct maintenance through inspection and early repair using the inventory

The staff of ARAs apply the above inventory to routine patrol and proper maintenance of structures.

* Above activities shall be conducted as a routine works of ARAs, and no particular expenses occur.

6. Human Resource and Institutional Development

6-1 To conduct training courses in order to strengthen institutional capacity of water related disaster risk management of DNGRH and ARAs.

It is an important challenge to enhance capacity of DNGRH and ARAs staff, who are in charge of water related disaster risk management and river management. In order to develop knowledge and skill of the staff, a training on comprehensive river and flood management should be implemented regularly.

[Condition of cost estimate]

- It is assumed that the training courses on the comprehensive river and flood management are conducted by the lecturers with proven experiences in water resources and flood management, inviting from universities in South Africa
- Number of Lecturers: 3 experts from South Africa
- Numbers of trainees/participants: 25 persons (4 persons x 5 ARAs + 5 DNGRH engineers and technicians)
- Venue of training courses: Meeting room of DNGRH will be utilized.
- Number of training courses / year: 1 training course (17 days)/ year

Item	Unit Price (USD)	Quantity		Amount (USD)	Remarks
		Qty	Unit		
(1) Honorarium for experts	250	17	days	4,250	
(2) Travel expenses of experts	400	3	lecturers	1,200	Air fare (Johannesburg - Maputo) round trip
(3) Accommodation allowance for experts	100	16	nights	1,600	
(4) Per diem allowance for expert	50	17	days	850	
Total (USD)				7,900	

Item	Unit Price (MT)	Quantity		Amount (MT)	Remarks
		Qty	Unit		
(1) Printing of materials	50	25	sets	1,250	assuming 25 trainees (4 persons x 5 ARAs + 5 DNGRH engineers and technicians)
(2) Meeting expenses (lunch and coffee)	1,500	476	sets	714,000	Lunch and coffee: 28 persons x 17 days=476 set
(3) Air fare (Maputo-Beira)	22,000	4	trips	88,000	Economy class, round trip
(4) Air fare (Maputo-Tete)	27,000	4	trips	108,000	- ditto -
(5) Air fare (Maputo-Nampula)	40,000	4	trips	160,000	- ditto -
(6) Air fare (Maputo-Pemba)	36,000	4	trips	144,000	- ditto -
(7) Accommodation allowance for trainee	6,000	272	nights	1,632,000	16 persons x 17 nights =272 nights
(8) Per diem allowance for trainee	2,000	288	days	576,000	16 persons x 18 days =288 nights
Total (MT)				3,423,250	

6-2 To establish a new department that oversee operation and maintenance of the river facilities, river spatial control, water use right, etc.

Although the river management in Mozambique is in charge of ARAs, it is required to establish new department in DNGRH to superintend not only the river management activities, but also spatial management of rivers and water use rights, from the policy aspect.

[Condition of cost estimate]

- It is assumed that the on-the-job training is conducted by river management experts.
- Number of river management experts: 1 short-term expert
- Duration of training: 6 months

Item	Unit Price (USD)	Quantity		Amount (USD)	Remarks
		Qty	Unit		
(1) Remuneration					
• River planning expert	20,000	6	person-month	120,000	Dispatch of a expert for 6 person-month to DNGRH
(2) Travel expense		1	lump sum	34,000	Traveling cost, accommodation and daily allowance
(3) Direct expenses		1	lump sum	10,000	Other direct cost
Total				164,000	

6-3 To incorporate the training syllabus about water related disaster risk management, which made in the Assistance, into the annual training plan of DNGRH

The training syllabus on water related disaster risk management prepared in the Assistance should be incorporated into the annual training plan of DNGRH in order to develop the capacity of the engineers and technicians of DNGRH and ARAs.

* The cost of the training is included in the above item 6-1.

Note: This cost estimate of the Action Plan has been jointly prepared by DNGRH and JICA team on a preliminary basis.
The JICA team does not assume any responsibility for the estimated cost.

APPENDICES

List of Appendices

Appendix - 1

Common Activity

Appendix 1-1

Minutes of Meeting on Work Plan

Presentation of Work Plan

MINUTES OF MEETING
ON
WORK PLAN
FOR
ASSISTANCE FOR ENHANCEMENT OF INSTITUTIONAL CAPACITY TO MANAGE WATER RELATED DISASTER RISKS IN MOZAMBIQUE
BETWEEN
NATIONAL DIRECTORATE OF WATER
AND
JAPAN INTERNATIONAL COOPERATON AGENCY

Based on the Minutes of Discussions of the Project, Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks in Mozambique (hereinafter referred to as "the Assistance") signed on June 13, 2014, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched to Mozambique the JICA Expert Team (hereinafter referred to as "the Team") composed of policy adviser and technical advisors from January 16, 2015 to explain the Draft Work Plan to Mozambique authorities concerned (hereinafter referred to as "Mozambican side").

As a result of the discussions, the contents of the Work Plan and the issues mentioned in the attached document were agreed by representatives of related agencies at the meeting held on February 19, 2015.

Maputo, February 26th, 2015

Dr. Hitoshi BABA
Policy Advisor, JICA Expert Team
Japan International Cooperation Agency

Engª. Suzana Saranga Loforte
National Director
National Directorate of Water
Ministry of Public Works, Housing and Water Resources
Government of the Republic of Mozambique

THE ATTACHED DOCUMENT

Participants agreed on the following:

1. Work Plan

The contents of the Assistance were agreed by Mozambican side as explained by the Team. The Assistance will be implemented according to the Assignment Schedule of JICA Experts and Work Schedule of the Assistance as attached in ANNEX-II and III respectively.

2. Points of Discussion

(1) The Assistance mainly focuses on flood disaster as water related disaster. Therefore, water quality issue and groundwater are not dealt with in the Assistance. However, from the viewpoint of the integrated water resource management, the Team will give advices on those issues.

(2) The Assistance utilizes free satellite based data as well as ground observed rainfall.

(3) Based on the results of baseline survey, current activities and necessary activities for water related disaster risk management are defined. And then, institutional development for water related disaster risk management will be proposed.

(4) Six persons will participate in Study Tour in Japan conducted in March 2015. 5 persons from DNA/ARAs and 1 person from INAM.

(5) Technology Transfer regarding river management will be conducted through on-the-job training in the selected pilot site. At central level, individual technology will be transferred mainly through workshops/seminars. Technology contents are decided based on the results of baseline survey.

(6) Equipment needed for hydrological observation is not provided by the Assistance. The Assistance will transfer knowledge and skills relating to managing water related disaster risks. However, hydrological data collection will be improved in cooperation with other projects.

(7) An effective dissemination of the transferred technology during the Assistance will be discussed in collaboration between the Team and Mozambican side.

(8) Mozambican side requested the Team to capacitate some staff as trainers, who will disseminate the transferred technology to other staffs after completion of the Assistance.

THE ATTACHED DOCUMENT

ANNEX I:	Attendant List
ANNEX II:	Assignment Schedule of JICA Experts
ANNEX III:	Work Schedule

ANNEX I: Attendant List

List of Participants of Meeting on Work Plan for Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks In Mozambique between National Directorate of Water and Japan International Cooperation Agency

(Maputo, 19th of February 2015 – Sala Modular da DNA)

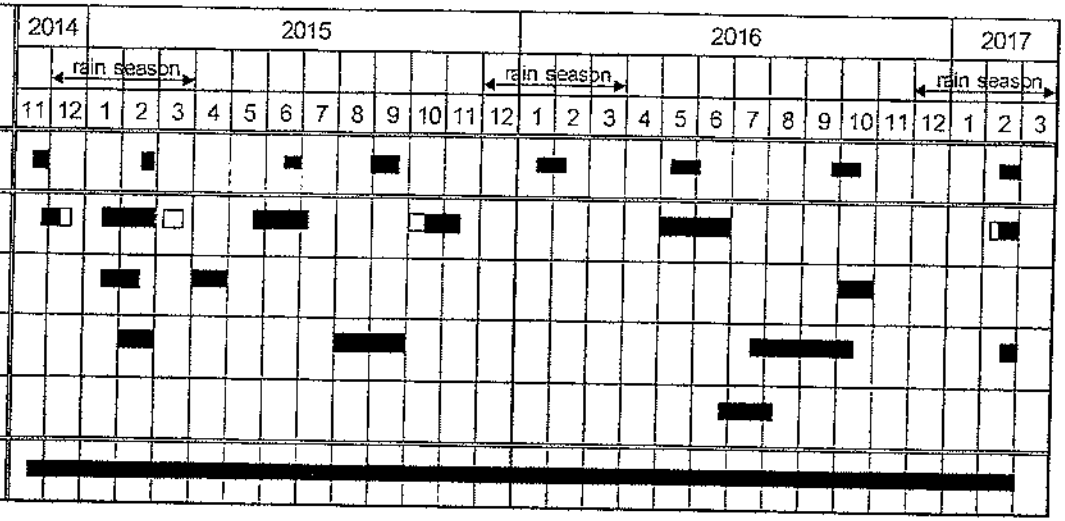
Nº	Participants	Institution
1	Directora Nacional de Águas	DNA /Direcção
2	Director Nacional Adjunto de Águas	DNA /Direcção
3	Chefe do Departamento de Recursos Hídricos	DNA /DRH
4	Chefe do Departamento de Obras Hidráulicas	DNA /DOH
5	Chefe do Departamento de Planificação	DNA /DP
6	Chefe do Departamento dos Rios Internacionais	DNA / DRI
7	Chefe do Departamento de Estudos Estratégicos	DNA /DEE
8	Egídio Govate	Técnico do DRH
9	Agostinho Vilanculos	Técnico do DRH
10	Francisco Naene	Técnico do DRH
11	Luisa da Conceição	Técnica do DRH
12	Etchissa Genesis	Técnica do DRH
13	Isac Filimone	Técnico do DRH

14	Carlos Mbenzane	Técnico do DRH
15	Valdemiro Escola	Técnico do DRH
16	Sheila Silva	Técnica do DRH
17	Justino Marrengula	Técnico do DRH
18	Cristóvão Xavier	Técnico do DRH
18	Renato Salomone	Técnico do DAS
19	Sra Florinda Pires	Técnica do DOH
20	Lizete Dias	Técnica da ARA Sul
21	Pedro Manjate	Técnico da ARA Sul
22	Jaime Mianga	Director GIPSA
23	Francisco Massangai	Técnico GIPSA
24	Itsuro ABE	Representante da Embaixada do Japão
25	Katsuyoshi SUDO	Director da JICA/Maputo
26	Megumi TSUKIZOE	JICA/ Maputo
27	Azarias Massuque	JICA/Maputo
28	Representante do INAM	INAM
29	Representante do INGC	INGC
30	Representante do CENOE	CENOE

31	Consultor do JICA- Projecto INAM	Coordenador do Projecto JICA /INAM
32	Hitoshi BABA	Consultor da JICA
33	Makoto KODAMA	Consultor da JICA
34	Hideki AKARI	Consultor da JICA
35	Arianna BOBBA	Consultora da JICA

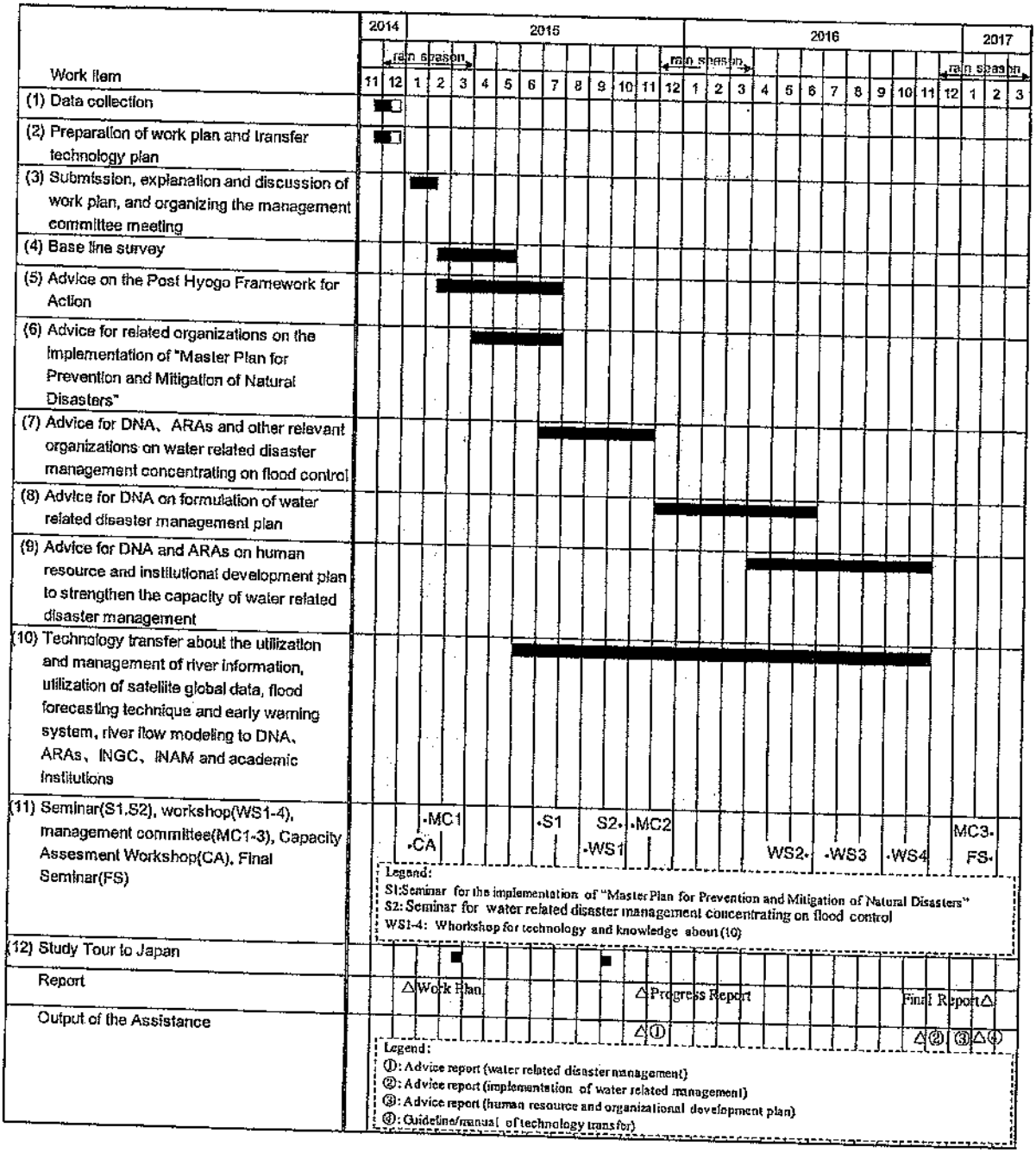
ANNEX II: Assignmnet Schedule of JICA Experts

Advisor Group	Position	Name
Policy Advisor		Hitoshi BABA
Technical Advisor	Team leader/ River plan	Makoto KODAMA
	Institutional development plan	Noritoshi MAEHARA
	River management technology	Hideki ARAKI
	Satellite based data	Hiroki KAI
Coordinator		Ariana BOBBA



■: activities in Mozambique, □: activities in Japan

ANNEX III: Work Schedule



ASSISTANCE
FOR
ENHANCEMENT OF INSTITUTIONAL CAPACITY
TO MANAGE WATER RELATED DISASTER RISKS
IN
MOZAMBIQUE

Project Name Assistance for Enhancement of Institutional Capacity to Manage Water Related Disasters in Mozambique
(*) This project mainly focus on flood disaster as water related disaster.

The project is a bilateral cooperative donation between the government of Japan and the government of Mozambique. It appeared after the flood of 2013 in Mozambique.

Objective DNA and other related organizations develop water related disaster management plan, and DNA and ARAs enhance river basin management capacity

JICA Tem Member

Policy Advisor:	Hitoshi BABA
Technical Advisor:	Makoto KODAMA (Team leader/River plan)
	Noritoshi MAEHARA (Institutional development)
	Hideki ARAKI (River management technology)
	Hiroki KAI (Satellite based data)
Coordinator :	Arianna BOBBA

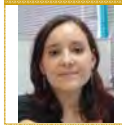
Period November 2014 - March 2017 (about 27 months)

JICA TEAM COMPOSITION

Policy Advisor

Hitoshi BABA

Coordinator



Arianna BOBBA

Technical Advisor

Makoto KODAMA

Hideki ARAKI

Noritoshi MAEHARA

Hiroki KAI

ASSIGNMENT SCHEDULE

Assignment Schedule

Advisor Group	Position	Name	2014	2015	2016	2017
			rain season	rain season	rain season	rain season
			11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3
Policy Advisor		Hitoshi BABA				
Technical Advisor	Team leader/ River plan	Makoto KODAMA				
	Institutional development plan	Noritoshi MAEHARA				
	River management technology	Hideki ARAKI				
	Satellite based data	Hiroki KAI				
Coordinator		Ariana BOBBA				

■: activities in Mozambique, □: activities in Japan

ASSISTANCE
FOR
ENHANCEMENT OF INSTITUTIONAL CAPACITY
TO MANAGE WATER RELATED DISASTER RISKS
IN
MOZAMBIQUE

WORK PLAN

February 19, 2015
JICA Team Makoto KODAMA

1. BACKGROUND

In recent years, development investment aiming toward economic growth is accelerated in Mozambique. On the other hand, natural disaster risk and the disaster damage have been increased because of climate change, development actions in domestic/neighboring countries, etc.

The national disaster management law was established in June 2014 after the long deliberation and the importance of the disaster management is increasingly recognized.

JICA and DNA discussed the component of a new project and confirmed the necessity of institutional strengthening to counter water related disaster. Finally both of them signed the minutes of discussion on "Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks in Mozambique"

2. OUTLINE OF THE ASSISTANCE

Overall Goal

- Institutional capacity of water related disaster risk management is enhanced in Mozambique.

Objective

- DNA and other related organizations develop water related disaster management plan
- DNA and ARAs enhance river basin management capacity

C/P

Implementing agency: DNA, ARAs
Related agency: MFE, INGC, INAM, ANE, DNHU, DNAPOT, MTARD, MINAG

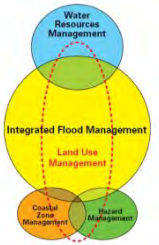
Duration

November 2014 - March 2017 (about 27 months)

3. BASIC POLICY

❶ Capacity improvement of river management based on the concept of the integrated flood management

Integrated Flood Management is a process promoting an integrated – rather than fragmented – approach to flood management. It integrates land and water resources development in a river basin, within the context of IWRM, and aims at maximizing the net benefits from the use of floodplains and minimizing loss of life from flooding.
(Integrated Flood Management Concept Paper, WMO 2004)



Technology Transfer Involving Various Organizations
Seminars and workshops will be held with the participation of various organizations.

Cost-effective River Management
To aim at utilization of satellite data, web-GIS, mobile phone, etc.

3. BASIC POLICY

❷ Technology Transfer and Study Tour to Japan Aiming at Taking Root Widely

For sustainable river management, transferred knowledge & skills and lessons learned from study tour to Japan should be disseminated widely and take root.

Technology Transfer Toward Practical Use

Discussion with C/P and JICA Team about expected, appropriate, and realistic knowledge and skills to be transferred.

Objective of The Study Tour of River Management to Japan

To acquire knowledge and skills for river management in Japan in order to utilize them in Mozambique

To make report and presentation of study tour to disseminate widely

3. BASIC POLICY

❸ Disaster Management Plan Applying Lessons Learned from the Great East Japan Earthquake

There are some lessons learned from the Great East Japan Earthquake, which can be applied to disaster risk management in Mozambique.

Lessons learned

Mutual support systems between affected and no-affected local governments were established smoothly based on good relationships constructed during ordinary times.

Lessons learned

Disaster management should have a viewpoint to deal with multi-hazard.

Lessons learned

Many school students could evacuate appropriately owing to disaster education in school.

3. BASIC POLICY

❹ Cooperation with JICA Meteorological project

Cooperative relation among related organizations through daily communication enhances capability of emergency response.

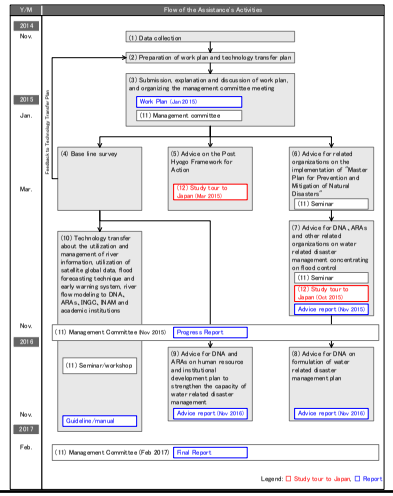
❺ Effective Publicity Activities and Final Workshop

Publicity activities by newsletters, pamphlets, poster, web-site and final workshop at the end of the Assistance participating as many as organizations

❻ Thorough Safety Management

Safety information sharing among related organizations, i.e. C/P, JICA, Japanese Embassy.

4. WORK FLOW



5. MAIN ACTIVITY

❶ Base Line Survey

Base line survey
To grasp fundamental information of the Assistance
- Main rivers
- Legal system
- Policy
- Organization
- Donor's projects

Based on the result, transfer technology is designed.
- field and item
- target organization/personnel
- schedule
- goal to be achieved, and others

Based on the result, review and advice regarding followings are implemented.
- HFA and post-HFA
- M/P of disaster prevention and mitigation
- water related disaster management
- human resources and institutional development plan

5. MAIN ACTIVITY

❷ Hyogo Framework for Action (HFA) and Post-HFA

- Review of HFA
- Invitation to 3rd World Conference on Disaster Risk Reduction
- Advice on Action Plan for Post-HFA

Progress of HFA

JICA Team will review of the progress of HFA based on "report on implementation of the Hyogo Framework for Action"

3rd World Conference on Disaster Risk Reduction in Japan

Participants: 4 persons
Duration: about 10 days including March 14–18, 2015
Objective: to learn Japanese DRR technology and system, and other counties' activities

Action Plan for post-HFA

JICA Team will give advice on preparing of Action Plan for post-HFA

5. MAIN ACTIVITY

❸ Master Plan for Prevention and Mitigation of Natural Disasters

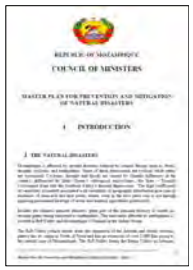
To collect new M/P for Prevention and Mitigation of Natural Disaster (2016 -) elaborated by INGC

↓

To review of new M/P analyze each organizations' responsibility, task, current status, issues, etc.

↓

To giving advice on implementing new M/P holding a seminar.



M/P (2006 ~)

5. MAIN ACTIVITY

❹ Water Related Disaster Management

Seminar on Water Related Disaster Management

Topic 1: River law, technical criteria for river works, flood control economic survey manual in Japan
Topic 2: Implementation of water related disaster management plan

Study Tour to Japan

Participants: 4 persons
Duration: about 10 days in October, 2015
Objective: to learn river management and flood control in Japan

Water Related Disaster Management Plan

Appropriate plan is needed to implement water related disaster management. JICA Team will support DNA to prepare water related disaster management plan through deep discussions with C/P.

❺ Human Resource and Institutional Development

Human Resource and Institutional Development Plan

For sustainable water related disaster management , appropriate personnel distribution is needed under appropriate institutional structure. JICA Team will advise DNA and ARAs on human resource and institutional development plan.

Advice Report

JICA Team will prepare Advice Report based on the above advice. It can be utilized for budget request, recruiting, training curriculum, etc.

❻ Transfer of knowledge and skills

Base line survey
(Capacity assessment)

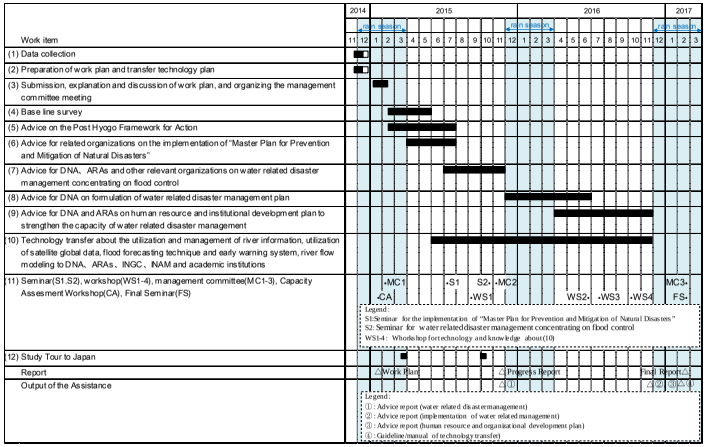
↓

Technology transfer plan

JICA Team will prepare a plan showing technology item, target organization / personnel and schedule based on the base line survey and discussion with C/P.

↓

- River/hydrological data collection, management and utilization
- Satellite based data utilization
- Flood forecast and early warning system
- River modeling
- Flood analysis report



The following points were agreed on Minutes of Discussion signed on June 13, 2014.

- The DNA provides adequate office space for JICA Experts in DNA.
- The Mozambique side confirmed that they will take necessary measures to ensure allocation of certain amount of budget for the activities of counterpart personnel for the Assistance including their salaries and other allowances.
- The Mozambique side bears customs duties, internal taxes and any other charges, imposed on the equipment related to the Assistance in the Mozambique.
- The Mozambique side bears expenses for transportation of counterparts within the Mozambique and maintenance of the equipment provided by JICA.

Muito Obrigado

AP - 18

Appendix 1-2

Minutes of Meeting on Progress Report

Presentation of Progress Report

MINUTES

OF

MANAGEMENT COMMITTEE MEETING

FOR

ASSISTANCE FOR ENHANCEMENT OF INSTITUTIONAL CAPACITY TO MANAGE WATER RELATED DISASTER RISKS IN MOZAMBIQUE

BETWEEN

NATIONAL DIRECTORATE OF WATER

AND

JAPAN INTERNATIONAL COOPERATON AGENCY

Maputo, December 4th, 2015

Based on the Minutes of Discussions of the Project, Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks in Mozambique (hereinafter referred to as "the Assistance") signed on June 13, 2014 between National Directorate of Water (hereinafter referred to as "DNA") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA has been implementing the Assistance since November 22, 2014 by dispatching JICA Expert Team (hereinafter referred to as "the JICA Team") to Mozambique.

The Management Committee Meeting of the Project was held on December 4, 2015 at DNA meeting room between the members of the Management Committee of the Project and the JICA Team.

As a result of the Management Committee Meeting, both Mozambique side and the JICA Team agreed on the matters referred to in the document attached hereto.

Mr. Makoto KODAMA
Team Leader, JICA Expert Team
Japan International Cooperation Agency

Eng. Suzana Saranga Loforte
National Director
National Directorate of Water
Ministry of Public Works, Housing and Water Resources
Government of the Republic of Mozambique

THE ATTACHED DOCUMENT

Participants in the meeting agreed on the following:

1. Progress Report

   The contents of the Progress Report were agreed by Mozambican side as explained by the Team. The Assistance will be implemented according to the Assignment Schedule of JICA Experts and Work Schedule of the Assistance as attached in ANNEX-II and III respectively.

2. Discussed Points

   (1) The JICA Team recommended to strictly control the quality of hydrological data collected in the field, firstly by ARAs and their River Basins Management Units, which are close to the rainfall and hydrometric stations. In a second phase the same data, before being processed and stored in the national database, must also be checked by DNA.

   (2) The JICA Team supports improving the contents and the concept of the Early Warning Messages, Hydrological Bulletins and System. It does not provide any specific tool for communication, e.g. radio or mobile phone.

   (3) The activity of advice on formulation of water related disaster management plan includes the study of construction measures, e.g. dike, bank protection, channel improvement, etc. But the activity is involved with planning phase not construction phase.

   (4) The JICA Team will introduce JICA's sectoral training regarding flood disaster mitigation, integrated water resources management or disaster risk management, etc. held in 2016.

   (5) The JICA Team uses free data and free software, i.e. satellite observed rainfall data, DEM, QGIS, IFAS, iRIC, in consideration of sustainability. If topographical condition is changed after the 2015 flood and the change is too large to ignore, the change is reflected on the river model.

   (6) The river model is constructed in consideration of groundwater runoff using "tank" parameter. And it prepares land cover parameter. The Management Committee of the Project suggested to use a soil parameter.

   (7) The Management Committee of the Project requested the JICA team to elaborate a user friendly river model. For example, technicians can easily understand flood scale with

water level but the river model for flood forecast shows discharge not water level.

(8) The JICA Team explained that it is difficult to show water level due to software specifications but the warning level of discharge can be calculated from determined warning water level.

(9) The flood forecasting model will be tested in the rainy season 2015/2016. After rainy season, the JICA Team and C/Ps will improve the accuracy of the model through verification and calibration. The model is operated in Japan. Technicians will be able to monitor the test run in Mozambique.

(10) The JICA and the Management Project Committee agreed on necessity to synchronize and coordinate the activity schedule in order to conduct the Assistance efficiently.

(11) The Management Project Committee requested JICA to provide the possibility for the JICA Team to visit Mozambique for longer periods than one or two months, in order to improve the effectiveness of the technology transfer and technical assistance.

THE ATTACHED DOCUMENT

ANNEX I: Attendant List

ANNEX II: Assignment Schedule of JICA Experts

ANNEX III: Work Schedule

ANNEX I: Attendant List

Mozambican side:

Suzana Loforte	DNA	National Director
Helio Banze	DNA	Deputy
Rute Nhamucho	DNA/DRH	Head of DRH
Custodio Vincente	ARA Zambeze	General Director
Carlos A.J. Nhaca	ARA Norte	General Director
Agnelo Jorge	ARA - Centro	Head of DRH
Issaca Vilanculo	MIDATER	Technician
Inocencio Escova	ARA CN	General Director
Berino Silinto	INAM	Head of Department
Anacleto Duvane	INAM	Deputy
Xavier Gulile	INGC/CENOE	Technician
Isac Filimone	DNA/DRH	Technician
Armando Cuinhane	DNA/DRH	Technician
Agostinho Vilanculos	DNA/DRH	Technician
Egidio Govate	DNA/DRH	Technician
Bernardino Novela	DNA	Head of DEE
Francisco Naene	DNA	Técnico do DRH
Cristovao Xavier	DNA	Focal Point
Alexandra Cardoso	WB/PNDRH	Team Leader A.T. PNDRH
Domingos Mosquito	DNA	Assistência Técnica PNDRH
Sr. Fredrik Huthoff	Netherland Cooperation	Team Leader HKV

Japanese side:

JICA Mozambique Office

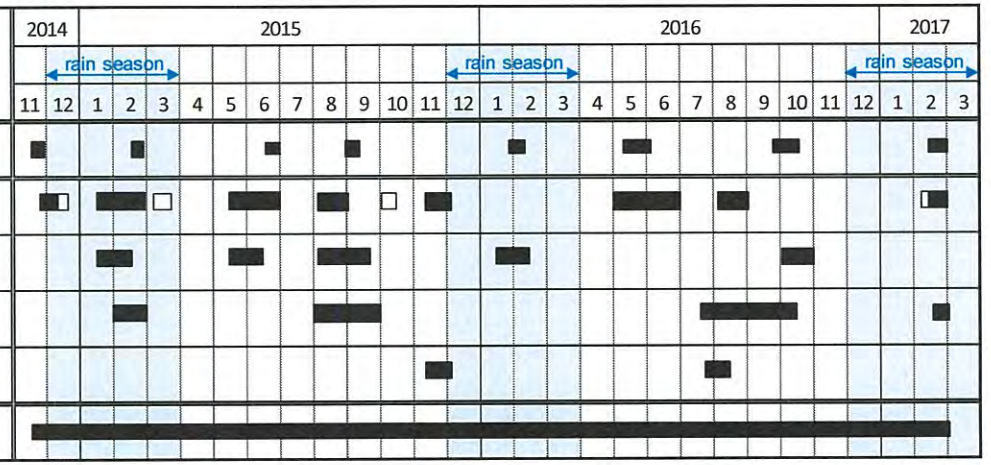
Mr. Katsuyoshi SUDO	Director of JICA Mozambique Office
Ms. Chiharu MORITA	Deputy Director of JICA Mozambique Office
Ms. Makiko INAMORI	Representative of JICA Mozambique Office
Mr. Stelio Massuque	Program Officer of JICA Mozambique Office

JICA Team

Mr. Makoto KODAMA	Technical Advisor: Team Leader/River Plan
Mr. Hiroki KAI	Technical Advisor: Satellite Based Data
Ms. Arianna BOBBA	Project Coordinator

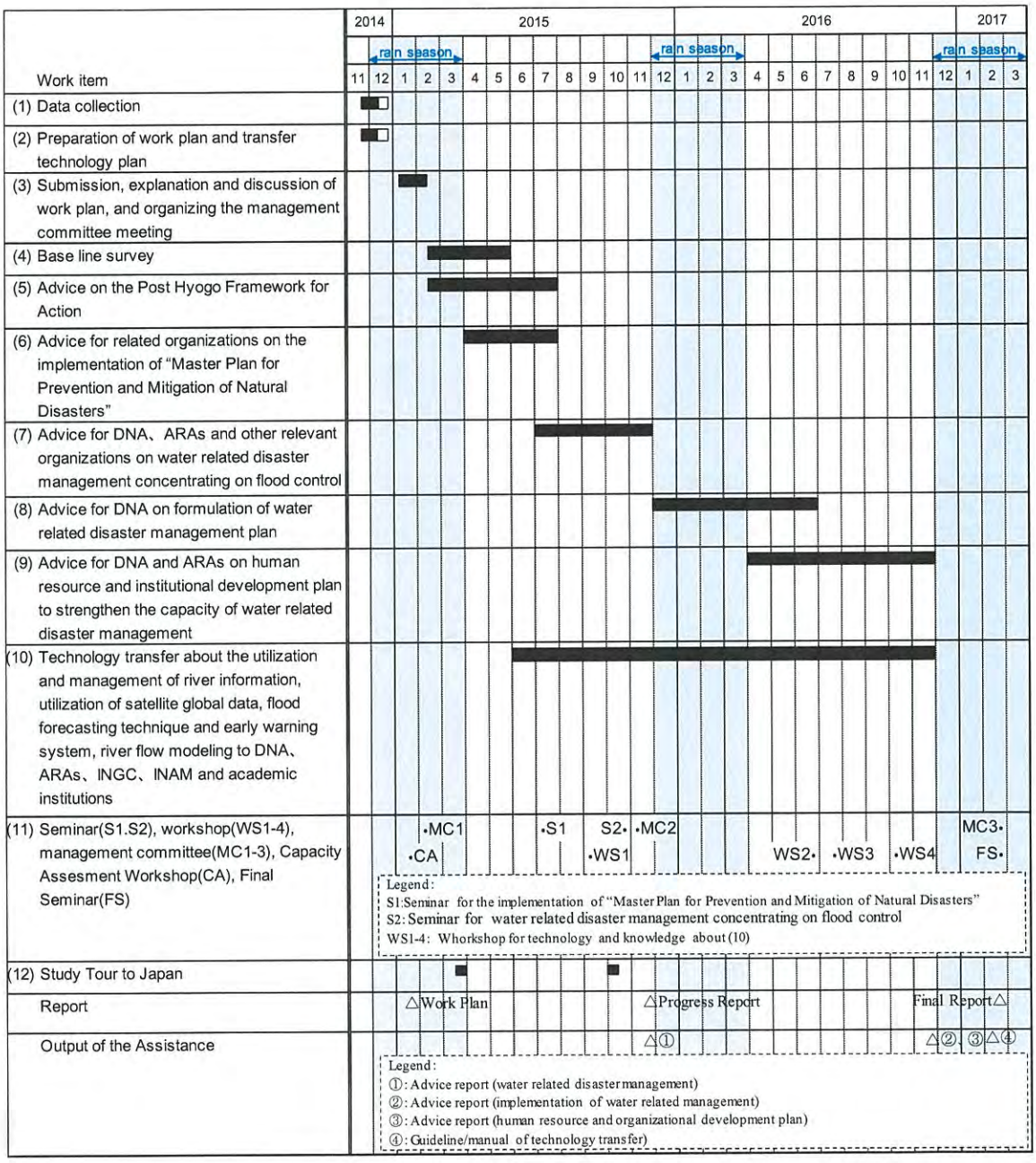
ANNEX II: Assignmnet Schedule of JICA Experts

Advisor Group	Position	Name
Policy Advisor		Hitoshi BABA
Technical Advisor	Team leader/ River plan	Makoto KODAMA
	Institutional development plan	Noritoshi MAEHARA
	River management technology	Hideki ARAKI
	Satellite based data	Hiroki KAI
Coordinator		Ariana BOBBA



■: activities in Mozambique, □: activities in Japan

ANNEX III: Work Schedule



ASSISTÊNCIA
AO
FORTALECIMENTO DA CAPACIDADE INSTITUTIONAL PARA
GERIR DESASTRES RELACIONADOS COM A AGUA
EM
MOÇAMBIQUE

Relatório de Progresso

4 de Dezembro de 2015
JICA Team Makoto KODAMA

AP - 29

1. CONTEXTO

Nos últimos anos, os investimentos visando o desenvolvimento para o crescimento económico em Moçambique aceleraram-se muito. Por outro lado, o risco de desastres naturais e os seus danos aumentaram por causa das mudanças climáticas, das actividades de desenvolvimento dos países vizinhos, actividades domésticas, etc.

Em mais, a lei de gestão dos desastres foi estabelecida em Junho de 2014 depois de uma longa deliberação e o reconhecimento da importância da gestão dos desastres.

A JICA e a DNA discutiram as componentes do projecto e confirmaram a necessidade de um fortalecimento institucional para fazer face aos desastres relacionados com a agua. Por fim, as duas organizações assinaram uma minuta de discussão (MD) mudando o nome do projecto para: Assistência ao Fortalecimento da Capacidade Institucional na Gestão dos Riscos de Desastres Relacionados com Agua em Moçambique.

2

2. PERFIL DA ASSISTÊNCIA

Objectivo Geral

- Assistência Para o Reforço da Capacidade Institucional para Gerir Riscos de Desastres Relacionados com a Água em Moçambique

Objectivo:

- A DNA e outras organizações relacionadas desenvolvem um plano de gestão de desastres relacionado com agua.
- A DNA e as ARAs melhoram as capacidades de gestão das bacias hidrográficas.

C/P

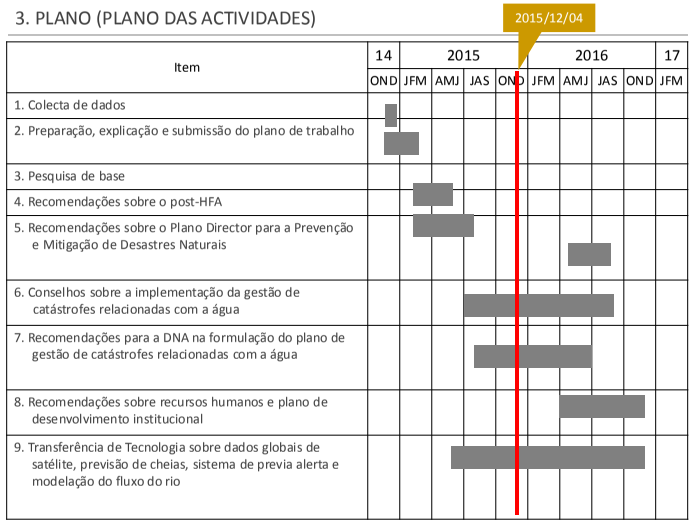
Agencia de Implementação: DNA, ARAs
Agencia Relacionas: MFE, INGC, INAM, ANE, DNHU, DNAPOT, MTARD, MINAG

Duração

Novembro de 2014 - Março de 2017 (cerca de 27 meses)

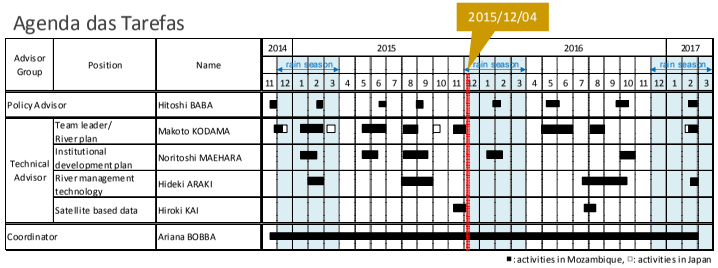
3

3. PLANO (PLANO DAS ACTIVIDADES)



3. AGENDA (AGENDA das TAREFAS)

Agenda das Tarefas



5

4. ACTIVIDADES PRINCIPAIS

4.1 Pesquisa de base

4-2 Recomendações sobre o Post-HFA

4-3 Recomendações sobre o Plano Director para a Prevenção e Mitigação de Desastres Naturais

4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

4-5 Recomendações para a DNA na formulação do plano de gestão de catástrofes relacionadas com a água

4-6 Recomendações sobre recursos humanos e plano de desenvolvimento institucional

4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

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4.1 Pesquisa de base

(1) Objectivo

- Compreender informações fundamentais sobre a gestão de desastres relacionados com a água em Moçambique.
- Compartilhar a consciência comum dos problemas relacionados com a gestão de rios

(2) Metodologia

- Colecta de dados e entrevistas
- Organização do workshop sobre a Gestão do Ciclo de Projecto (GCP) e Scenario-driven Tabletop Exercise para a revisão da cheia de 2015

7

4.2 Pesquisa de base

(3) Resultados da pesquisa de base

Actividades de redução do risco de desastres enfocadas na assistência

Item	Actividades
1. Utilização dos dados hidrologicos	• Reformular as estações de observação hidrológica (especialmente o estado de funcionamento) • Fazer o controle de qualidade pelas unidades da estações não perto da DNA • Compartilhar dados hidrológicos entre DNA / ARAs e INAM
2. Gestão da Estructura do Rio	• Fazer uma revisão do inventario das estructuras • Preparar o inventario das estruturas do rio usando o GIS
3. Gestão do risco de cheia	• Desenvolver EWS usando dados de precipitações do satelíte • Construir modelos de simulação de cheia • Desenvolver o plano de gestão de cheia
4. Desenvolvimento dos recursos humanos	• Desinhar o treinamento do curricula de gestão de rio

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4. ACTIVIDADES PRINCIPAIS

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4-2 RECOMENDAÇÕES SOBRE O POST-HFA

(1) Sendai Framework para a RRD

- Seminário sobre o HFA e o Post*-HFA Zero-draft antes da 3ª Conferencia Mundial sobre a RRD (WCDRR)
- Seminário sobre o Framework de Sendai sobre a RRD depois da 3ª

(2) Visita de Estudo no Japão (3ª WCDRR)

- Participação na 3ª Conferencia Mundial de RRD em Sendai, Japão
- Palestra do Ministério da Terra, Infra-estrutura, Transporte e Turismo (MLIT)
- Palestra sobre a observação e previsão meteorológica da Agencia Meteorológica do Japão (JMA)
- Visita de Campo na ponte de Ajuste de Arakawa

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4. ACTIVIDADES PRINCIPAIS

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4-3 RECOMENDAÇÕES SOBRE O PLANO DIRECTOR DE PREVENÇÃO E MITIGAÇÃO DE DESASTRES NATURAIS

2005: Foi estabelecido o Plano Director para a Prevenção e Mitigação dos Desastres Naturais (2016-)

2016: O P/D será revisto. Está a ser revisto neste momento
=> Por esta razão, esta actividade ainda não começou

P/D (2006 ~)

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4. ACTIVIDADES PRINCIPAIS

4.4 Pesquisa de base

4-2 Recomendações sobre o Post-HFA

4-3 Recomendações sobre o Plano Director para a Prevenção e Mitigação de Desastres Naturais

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4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

(1) Seminário sobre a Gestão de Desastres relacionados com a Água

(2) Visita de Estudo no Japão

(3) Conselhos sobre os Sistemas de Gestão de Rios

(4) Distribuição da Informação de fácil compreensão sobre desastres

14

4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

(2) Visita de Estudo no Japão

- Palestra do Ministério da Terra, Infra-estrutura, Transporte e Turismo (MLIT)
- Bacia de retardamento do rio Tsurumi
- Desvio do Rio Shinano
- Regulação de reservatório usando campos de cultivação
- Formações praticas utilizando dados de satélite


防災担当官が来市
洪水対策の現状などを視察

15

4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

(3) Conselhos sobre os Sistema de Gestão de Rio

- Preparação do inventário das estruturas de gestão de rio para a manutenção dessas funções.
- Deve ser estabelecido um sistema sustentável e um método para a gestão do rio utilizando o inventário.

16

(3) Conselhos sobre os Sistema de Gestão de Rio

Preparação do inventá rio para a manutenção dessas fu

Esta actividade irá continuar durante o próximo ano

17

(4) Distribuição da Informação de fácil compreensão sobre Desastres

Lei de Gestão de Desastres N. 15/2014

Artigo 6 (Prevenção)

- 2. O Governo regula o controlo das bacias hidrográficas e o sistema eficaz de aviso prévio que permita a monitoria e prevenção de fenómenos hidro meteorológicos que possam causar calamidades.

Artigo 15 (Sistema de aviso prévio)

- 2. O aviso prévio pode ser local ou nacional, conforme a área territorial abrangida pélo risco de ocorrência da calamidade.

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(4) Distribuição da Informação de fácil compreensão sobre Desastres

Metodologia

Entrevistas e questionários com agencias relevantes

Colecta de exemplos de informação de desastres

Workshops com membros dos comités de gestão de risco de desastres das comunidades

Compreender as rotas actuais, os significados, as mensagens de informação de desastre

Para analisar questões relacionadas com a informação actual de desastres

Para propor melhorias na informação de desastres

19

(4) Distribuição da Informação de fácil compreensão sobre Desastres

Recomendações

- Recomendações para a emissão da ordem de evacuação
- Expressões com sentido de emergência
  Por exemplo,
  - - "Uma inundação maciça que nunca temos experimentado nos últimos anos"
  - - "Uma inundação severa que é comparável com aquela da inundação de 2015"
  - - "Fortes chuvas que nunca temos experimentado nos últimos anos"
  - - "Um ciclone forte mais forte do que o ciclone Funso em 2012"
- Titulo do Comunicado
- Recomendação de implantar a UNAPROC (desde a DNA para o CENOE)
- Não usar termos técnicos como Alerta vermelha na radio comunitária

Esta actividade irá continuar durante o próximo ano

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4. ACTIVIDADES PRINCIPAIS

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4-2 Recomendações sobre o Post-HFA

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4.5 Recomendações na formulação do plano de gestão de catástrofes relacionadas com a água

A equipa da JICA tem apoiado a DNA / ARAs para formular o plano de gestão de desastres no rio Licungo. O plano será preparado como mostra o fluxo seguinte. As actividades de algumas componentes do fluxo foram realizadas na Assistência, como no sistema de previa alerta de inundação, a informação de desastre, precipitação por satélite, etc.

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4.5 Recomendações na formulação do plano de gestão de catástrofes relacionadas com a água

Esta actividade irá começar no próximo ano

1. Entender a condição actual de uma bacia hidrográfica
2. Estudar medidas estruturais
3. Avaliar as opções de medidas estruturais
4. Considerar medidas não-estruturais
5. Estabelecer e determinar um plano de gestão dos riscos de inundações
6. Manter estruturas de gestão dos rios

Fluxo de Formulação para um Plano de Gestão Integrada das Cheias

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4. ACTIVIDADES PRINCIPAIS

4.4 Pesquisa de base

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4-6 Recomendações sobre recursos humanos e plano de desenvolvimento institucional

Situação Actual

Em acordo com os treinamentos actuais da Divisão de Recursos Humanos, quase todos são em abastecimento de água e saneamento para engenheiros e técnicos da DNA, ARAs e pessoal do governo nacional e distrital.

No período sucessivo

A Equipa da JICA irá propor planos de formação em gestão de riscos de desastres relacionados com a agua

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4. ACTIVIDADES PRINCIPAIS

4.4 Pesquisa de base

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4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

(1) Gestão de Dados Hidrológicos

(2) Modelação de Rio

(3) Previsão de Cheia e Sistema de Previa Alerta

27

4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

(1) Gestão de Dados Hidrológicos

Mapa de localização das estações hidrológicas
Lista dos file de dados
Lista das estações com dados disponíveis

Para o período sucessivo:
Precipitação media da bacia
Analise das probabilidades (ponto de precipitação, Precipitação e descarga media da bacia)
Revisão do sistema da base de dados hidrológicos

28

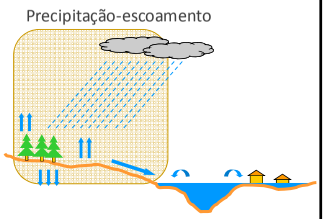
(2) Modelação de Rio

Modelo de analise de precipitação-escoamento

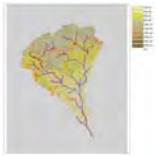
Chuvas em uma área de influência

↓

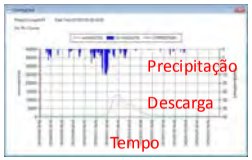
Descarga no ponto (Q)



IFAS (Integrated Flood Analysis System)



Modelo de um Sistema de Rio



Perfil da analise

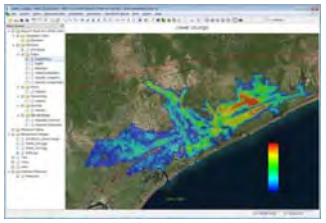
(2) Modelação de Rio

Modelo de analise do fluxo de cheia

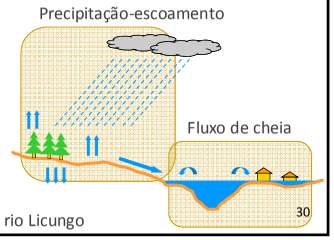
Descarga na extremidade superior no ponto calculado (Q) do rio

↓

- Nível de agua e descarga em qualquer ponto do rio
- Comportamento do fluxo do rio



Perfil da analise na extremidade inferior do rio Licungo



(2) Modelação de Rio

Formação técnica sobre analise de modelação de rio

Data	2015/08/10 – 08/21	2015/08/27 – 09/10
Lugar	Maputo	Nampula
Participantes	15 pessoas: DNA, ARA-Sul, ARA-Zambeze, ARA-Centro, INAM, INGC/CENOE	22 Pessoas: ARA-Centro Norte, ARA-Norte, INGC, DPOPH, DPASA-NPL, FIPAC-NPL

Esta formação irá continuar em 2016

(3) Previsão de Cheia e Sistema de Previa Alerta

Modelo de precipitação-escoamento (IFAS => Auto IFAS)

+

Precipitação observada por satélite
[dados horários em toda a bacia com malha de 10 km]

↓

Previsão de cheia e sistema de previa alerta

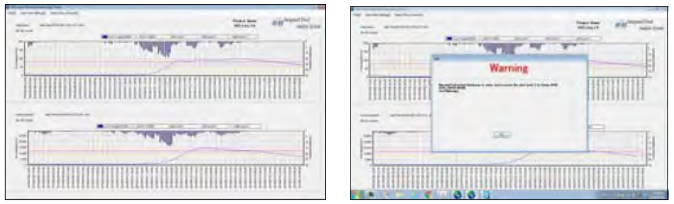
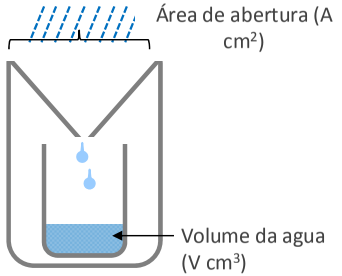


Imagem de auto IFAS

5. MEDIÇÃO DA PRECIPITAÇÃO

A quantidade de precipitação é exprimida usando mm em altura



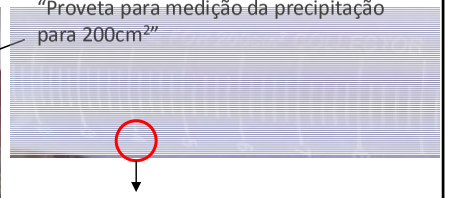
Quantidade da precipitação = Volume da agua / Área de abertura = V/A

Fazer a calculação todas as vezes pode causar problemas

↓

5. MEDIÇÃO DA PRECIPITAÇÃO

É utilizada uma proveta de medição, que foi preparada em acordo com a área de abertura



Isso mostra 4 mm quando usa-se um colector (pluviómetro) com 200cm² de área de abertura.

5. MEDIÇÃO DA PRECIPITAÇÃO

Se é usada uma proveta de medição da precipitação inadequada, a quantidade de precipitação é medida incorrectamente.

Para 200cm²

Diametro: 5 polegadas
Area da abertura: 127cm²

Em uma estação, a medida usada da precipitação é 200 cm².
O diâmetro da abertura é 5 polegadas (= 12.7cm)
A Área de abertura é: 3.14 x 12.7^2 / 4 = 127 cm²

↓

A estimação da quantidade de precipitação é de 63% (= 127/200) do valor real

Precipitação medida (mm)	Precipitação real (mm)
10 mm	15.9 mm
20 mm	31.7 mm
50 mm	79.4 mm
100 mm	158.7 mm
200 mm	317.5 mm

5. MEDIÇÃO DA PRECIPITAÇÃO

Recomendações

Pesquisa a nível nacional para identificar a medida da abertura dos colectores (pluviómetros) e a especificação das provetas de medição da precipitação

Muito Obrigado

AP - 38

Appendix 1-3

Minutes of Meeting on Draft Final Report

Presentation of Draft Final Report

MINUTES

OF

MANAGEMENT COMMITTEE MEETING

FOR

ASSISTANCE FOR ENHANCEMENT OF INSTITUTIONAL CAPACITY TO MANAGE WATER RELATED DISASTER RISKS IN MOZAMBIQUE

BETWEEN

NATIONAL DIRECTORATE OF WATER RESOURCES MANAGEMENT

AND

JAPAN INTERNATIONAL COOPERATON AGENCY

Maputo, December 8th, 2017

Based on the Minutes of Discussions of the Project, Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks in Mozambique (hereinafter referred to as "the Assistance") signed on June 13, 2014 between National Directorate of Water Resources Management (hereinafter referred to as "DNGRH") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA has been implementing the Assistance since November 22, 2014 by dispatching JICA Expert Team (hereinafter referred to as "the JICA Team") to Mozambique.

The Management Committee Meeting of the Project was held on December 8, 2017 at DNA meeting room between the members of the Management Committee of the Project and the JICA Team.

As a result of the 3nd Management Committee Meeting, both Mozambique side and the JICA Team agreed on the matters referred to in the document attached hereto.

Mr. Makoto KODAMA
Team Leader, JICA Expert Team
Japan International Cooperation Agency

Mr. Messias Macie
National Director
National Directorate of Water Resources Management
Ministry of Public Works, Housing and Water Resources
Government of the Republic of Mozambique

THE ATTACHED DOCUMENT

Discussed Points:

(1) DNGRH requested the JICA team to estimate the cost for implementation of Action Plan. After the meeting, DNGRH and the JICA Team discussed and agreed that both of them will estimate the cost in cooperation with each other.

(2) In the Management Committee Meeting, the JICA team reported some issues/problems, but there are many positive aspects as stated by a participant. For example, almost all the engineers and technicians have strong intention to acquire knowledges and skills.

(3) Regarding database, Action Plan should focus on not only updating but also utilizing it and disseminating it to the public and other local authorities, Municipalities, Districts, etc. The database proposed in the Action Plan is that to be utilized not only by DNGRH and ARAs but also by other institutions such as INAM, OOO, etc. as a first step. The utilization may be expanded to local authorities, if necessary.

(4) Flood Early Warning Model runs 24 hours in the room of the Unit of Flood and Drought. Those who are interested in it can see it there anytime.

(5) ARAs eager to improve their capacity on flood early warning system. Responding to the request, Hydrological & Hydraulic Trainer and IFAS & Auto-IFAS Modeling Trainer certificated in the Assistance intend to conduct the training on flood early warning system for ARAs next year.

(6) IFAS/Auto-IFAS model, which were trained in the Assistance, is able to be applied for the river basin which controls flow discharge by a dam.

(7) Flood Early Warning System should be operated and maintained by ARA in charge of the target river basin from the view point of simple and prompt communication/response. When ARA secures stable internet/electric power supply, and enough capacity on it, the system should be transferred.

THE ATTACHED DOCUMENT

ANNEX I: Attendant List

ANNEX II: Assignment Schedule of JICA Experts

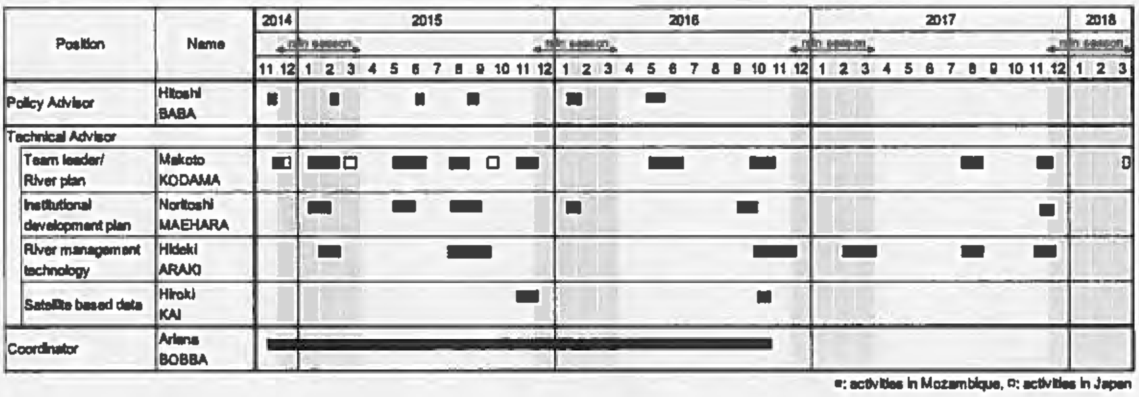
ANNEX III: Work Schedule

ANNEX I: Attendant List

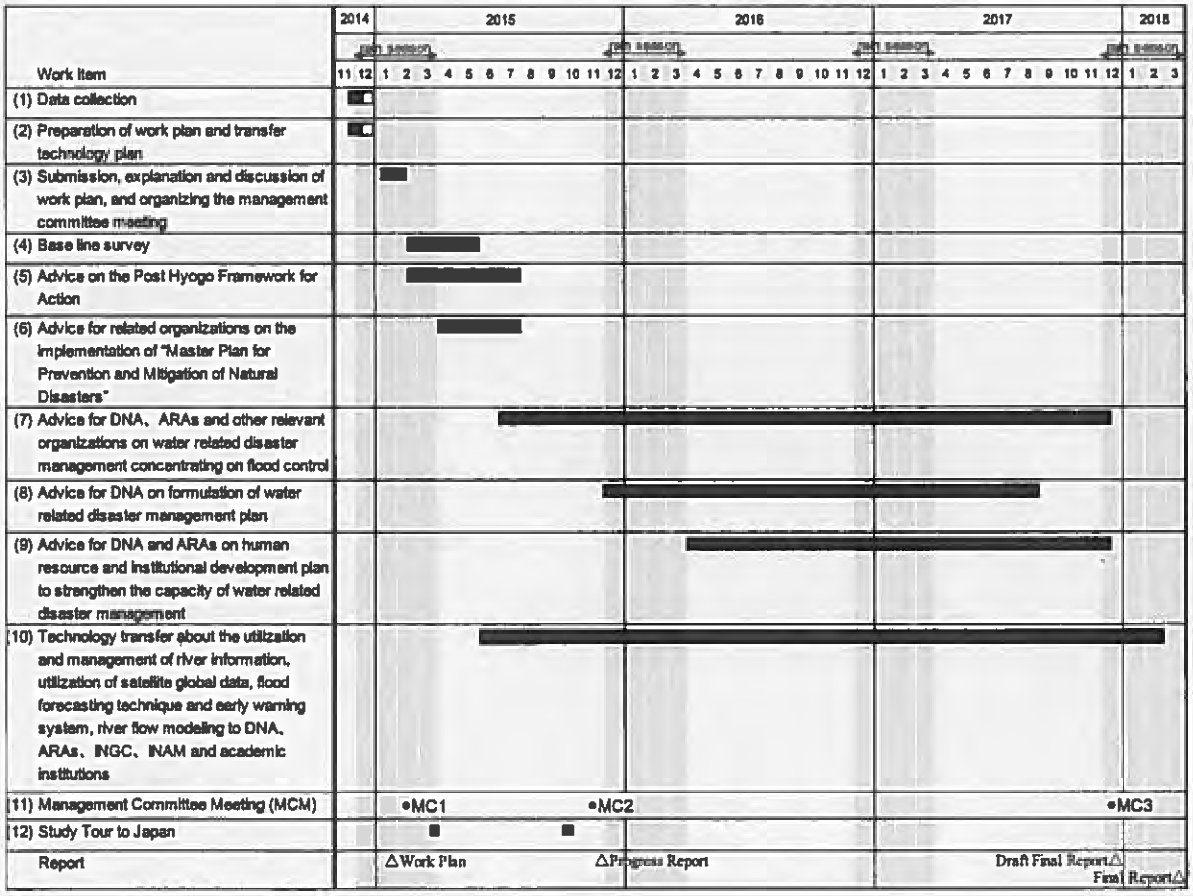
No.	Convidados	Instituição
1	Sr.Eduardo Jossefa	Chefe do Departamento de DOH
2	Sr. Hiroaki ENDO	Representante da JICA-Moçambique
3	Sra. Makiko Inamori	JICA – Moçambique
4	Sr.Sérgio Bento	Chefe do Departamento DRI
5	Sra. Celestina Zita	Chefe do Departamento do DAF
6	Sr.José Malanço	Chefe da Repartição DGBH
7	Sra.Isabel Fotine	Chefe da Repartição DGBH
8	Sr. Carlo Munjovo	Técnico do DP
9	Sr.Jaime Muianga	Director GIPSA
10	Sra.Alexandra Cardoso	Team Leader AT PNDRH
11	Sr.Ronaldo Inguane	PNDRH
12	Sr. Makoto KODAMA	Team Leader of JICA Project
13	Sr. Hideki ARAKI	Consultor da JICA
14	Sr.Noritoshi MAHAERA	Consultores da JICA
15	Sr.Isaac Filimone	Técnico do DGBH
16	Sr. Carlos Jopela	Técnico do DGBH
17	Sr.Justino Marrengula	Técnico do DGBH
18	Luisa da Conceição	Técnico do DGBH
19	Sr.Francisco Naene	Técnico do DGBH
20	Sr.Cristovão Xavier	Técnico do DGBH
21	Sr. Armando Cuinhane	Técnico do DNGRH
22	Sr. Pedro Fernandes	Técnico do DOH
23	Sra. Iolanda Bila	Técnico do DRI
24	Sra. Filoca Fondo	Técnico do DGBH
25	Sra. Arcina Nhavotso	Técnico do DGBH
26	Sr. Lucas Chairuca	Técnico do DGBH
27	Sra- Lily Nomboro	Técnico do DGBH
28	Sr. Omar Sirage	Técnico do DGBH
29	Sr. Ângelo Boavida	Técnico do DOH
30	Sr. Ernesto Tivane	Técnico do DGRH
31	Sra. Suzana	DNGRH/Cooperação Holandesa
32	Sr.Lenon Bila	Técnico do DGBH
33	Sr. Eurico Saize	Director Geral da ARA-Norte
34	Sr. Omar Calisto	Director Geral da ARA Centro-Norte
35	Sr. Vicente Custodio	Director Geral da ARA- Zambeze
36	Sra. Maruli Agostinho	Técnica da ARA- Centro/Mocuba
37	Sr. Nelson Malikito	Técnico da ARA-Centro/Chimoio
38	Sr. Feliciano Mataveia	Director do INGC/CENOE
39	Sr. Adérito Adamugy	Director Geral do INAM
40	Sr. Paiva Munguambe	Director Geral do INIR
41	Sra. Madalena Monteiro	Representante do MEF

42	Sra. Jadwiga Massinga	Representante de MITADER/DINAPOT
43	Sr.Gabriel Paulino Devesse	Tradutor

ANNEX II: Assignment Schedule of JICA Experts



ANNEX III: Work Schedule



REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DAS OBRAS PÚBLICAS, HABITAÇÃO E RECURSOS HÍDRICOS
DIRECÇÃO NACIONAL DE GESTÃO DE RECURSOS HÍDRICOS
DEPARTAMENTO DE GESTÃO DE BACIAS HIDROGRÁFICAS

Projecto para o Fortalecimento da Capacidade Institucional na Gestão dos Riscos de Desastres Relacionados com Água em Moçambique

Última Reunião do Comité de Acompanhamento do Projecto da JICA

Dia 8 de Dezembro de 2017

Horário	Actividade	Responsável
8:30-8:45	Notas Introdutórias e Abertura do Encontro	*Representante da JICA* *Director Nacional*
8:45 – 9:00	Apresentação dos Participantes	*Todos*
9:00– 9:45	***Apresentação do Relatório Final***	***Assistência Técnica da JICA (Sr. KODAMA)***
9:45 – 10:00	Discussão e Debate	Todos
10 :00 -10:30	***Transferência de Tecnologias na Gestão de Rios***	***Assistência Técnica da JICA (Sr. ARAKI)***
10:30 – 10:45	Discussão e Debate	Todos
10:45 – 11:00	***Intervalo para Café***	***Todos***
11-00 -11:20 ***11:20- 11:40***	***Modelo Hidrológico do Sistema de Aviso de Cheias IFAS & AUTO-IFA***	***a) Técnico do DGBH*** ***b) Técnica da ARA Centro-Norte***
11:40 – 12:00	**Importância da Promoção da Redução dos Riscos de Desastres pelas Instituições Nacionais**	***Assistência Técnica da JICA (Sr. MAEHARA)***
12:00- 12:15	Discussão e Debate	Todos
12:15- 12 30	Encerramento	*Representante da JICA* *Director Nacional*
12:30	***Almoço***	***Todos***

Rua de Imprensa Nº 162; 2º Andar; Tel: 21 309862; Fax: 21 305240

ASSISTÊNCIA
AO
FORTALECIMENTO DA CAPACIDADE INSTITUTIONAL PARA
GERIR DESASTRES RELACIONADOS COM A AGUA
EM
MOÇAMBIQUE

DRAFT FINAL REPORT

8 de Dezembro de 2017
JICA Team Makoto KODAMA

AP - 47

1. PERFIL DA ASSISTÊNCIA

Fundo

Nos últimos anos, os investimentos visando o desenvolvimento para o crescimento económico em Moçambique aceleraram-se muito. Por outro lado, o risco de desastres naturais e os seus danos aumentaram por causa das mudanças climáticas, das actividades de desenvolvimento dos países vizinhos, actividades domésticas, etc.

Em mais, a lei de gestão dos desastres foi estabelecida em Junho de 2014 depois de uma longa deliberação e o reconhecimento da importância da gestão dos desastres.

A JICA e a DNA discutiram as componentes do projecto e confirmaram a necessidade de um fortalecimento institucional para fazer face aos desastres relacionados com a agua. Por fim, as duas organizações assinaram uma minuta de discussão (MD) mudando o nome do projecto para: Assistência ao Fortalecimento da Capacidade Institucional na Gestão dos Riscos de Desastres Relacionados com Agua em Moçambique.

1. PERFIL DA ASSISTÊNCIA

Objectivo Geral

- Assistência Para o Reforço da Capacidade Institucional para Gerir Riscos de Desastres Relacionados com a Água em Moçambique

Objectivo

- A DNGRH e outras organizações relacionadas desenvolvem um plano de gestão de desastres relacionado com agua.
- A DNGRH e as ARAs melhoram as capacidades de gestão das bacias hidrográficas.

C/P

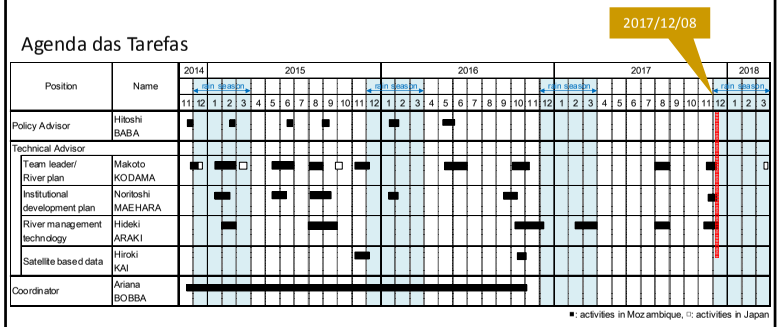
Agencia de Implementação: DNGRH, ARAs
Agencia Relacionas: MFE, INGC, INAM, ANE, DNHU, DNAPOT, MTARD, MINAG

Duração

Novembro de 2014 - Maio de 2018

1. PERFIL DA ASSISTÊNCIA

Agenda das Tarefas



2. SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION

Visita de Estudo no Japão em Março, 2015

- Participação na 3ª Conferencia Mundial de RRD em Sendai, Japão

Sendai Framework for DRR 2015-2030

Priorities for Action

(1) Understanding disaster risk

(2) Strengthening disaster risk governance to manage disaster risk

(3) Investing in disaster risk reduction for resilience

(4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

5

3. ATIVIDADES GERAIS

[1] Problemas

Pesquisa de base

Objectivo

- Compreender informações fundamentais sobre a gestão de desastres relacionados com a água em Moçambique.
- Compartilhar a consciência comum dos problemas relacionados com a gestão de rios.

Metodologia

- Colecta de dados, entrevistas e workshop

6

3. ATIVIDADES GERAIS

[1] Problemas | [2] Actividades | [3] Melhores conhecimentos e capacidades | [4] Próxima ação

Campo de atividades

A. Observação hidrológica/ dados hidrológicos
B. Características dos rios e bacias
C. Medidas estruturais
D. Sistema de Previsão e Alerta de Inundação
E. Fornecimento de informações sobre o desastre de fácil compreensão
F. Cadastro das Instalações de Controlo do Rio
G. Estrutura Organizacional/ Desenvolvimento de recursos humanos

7

4 REPORT of FIELD from A to G

A. Observação hidrológica/ dados hidrológicos

[1] Problemas

a. Existem vários bancos de dados.
b. Não há recursos para actualização da licença de uso do software de banco de dados.
c. Os dados hidrológicos não estão organizados.
d. Foram verificados valores anormais nos dados medidos no passado.
e. O número de estações de observação é insuficiente em relação ao tamanho das bacias hidrográficas. Este número é ainda mais limitado para estações de observação capazes de enviar dados em tempo real em situações de inundação.
f. Baixa confiabilidade de dados
   - Há descrença dos funcionários da DNGRH e ARA sobre a precisão dos dados hidrológicos observados pelos moradores locais
   - Baixa confiabilidade dos dados devido à desactualização da curva de descarga (HQ).

Regarding the above, we conducted the following activities…

8

4 REPORT of FIELD from A to G

A. Observação hidrológica/ dados hidrológicos

[2] Actividades

a. Elaboração do mapa de distribuição das estações de observação, e da lista dos dados coleccionados pelas estações de monitoria
b. Foi realizada orientação para utilização de dados de observação por satélite
c. Foi feita orientação prática sobre o método de levantamento topográfico da secção do rio necessário para a eleboração da curva HQ.
e. Foi fornecido à Unidade Mocuba o manual "Observação hidrológica ilustrada (versão em português)"
f. Orientação de elaboração à mão dos gráficos de pluviograma e hidrograma.

(For mismatched apparatus)

- A DNGRH solicitou investigação do assunto às respectivas delegações da ARA.

Through the activities, C/P improved/obtained the followings…

9

4 REPORT of FIELD from A to G

A. Observação hidrológica/ dados hidrológicos

[3] Melhores conhecimentos e capacidades

a. Foi esclarecido sobre o período de retenção dos dados de estação de observação.
b. Houve entendimento a respeito das questões existentes como a descontinuidade dos dados observados, a distribuição esparsa das estações de observação, atraso nos trabalhos de entrada de dados recentes, entre outras.
c. Houve entendimento sobre a possibilidade de ter ocorrido a partir de uma certa altura, inadequações no uso de equipamentos ou na própria metodologia de uso.
d. Aprendizado da necessidade de se usar uma curva HQ que esteja de acordo com o formato actual do canal do rio para obter o seu caudal correcto. E que para isso há a necessidade de se fazer um levantamento topográfico periódico da secção do rio.

10

4 REPORT of FIELD from A to G

e. Houve entendimento sobre os pontos importantes da observação hidrológica através deste manual de fácil compreensão graças às ilustrações.
f. Aprendizagem sobre como detectar valores anormais através da elaboração de gráficos dos valores observados.
g. Capacitação para levantamento topográfico simplificado da secção do rio graças à realização de treinamento prático.
h. Houve entendimento sobre a existência de várias ferramentas livres (gratuitas) de aproveitamento dos dados de observação por satélite, e aprendizagem do manuseio destas ferramentas.

After the Assistance, C/P will do the followings for next step…

11

4 REPORT of FIELD from A to G

A. Observação hidrológica/ dados hidrológicos

[4] Próxima ação

<u>Banco de dados hidrológicos</u>

a. Estabelecer banco de dados hidrológicos usando software
b. Integrar também neste novo banco de dados, os dados hidrológicos monitorados por outras instituições como o INAM, de modo a estabelecer uma estrutura de partilha de dados.

<u>Observação hidrológica</u>

a. Realização de inspecção sobre a metodologia de observação e de uso de equipamentos em todas as estação de observação.
b. Fazer com que os moradores locais os quais foram confiados o trabalho de observação entendam a importância dos dados hidrológicos, e orienta-los sobre os métodos de observação.
c. Verificação geral das curvas HQ existentes.
d. Verificar a discrepância entre os valores observados no momento da medição do caudal (nível de água e caudal) e a curva HQ e conferir a variação ocorrida na secção do rio.

12

4 REPORT of FIELD from A to G

e. Realizar de forma periódica levantamentos topográficos da secção do rio.

Desenvolvimento de capacidade

a. Nos sítios web do GSMaP e GFAS é possível verificar com facilidade o volume de precipitação e a sua escala de probabilidade. É importante aprofundar o seu entendimento pelo uso contínuo dessas ferramentas e observância da distribuição das chuvas e as direcções do movimento das áreas de chuva. Além disso, deve adquirir sensibilidade própria a respeito da precisão e diferenças que possam haver pela comparação do local onde se encontra e o volume pluviométrico indicado pela ferramenta.

13

4 REPORT of FIELD from A to G

B. Características dos rios e bacias

[1] Problemas

a. Insuficiente compreensão sobre os rios e as bacias
b. Necessidade de aprender o método de cálculo da capacidade de armazenamento de água para o caso de se construir uma barragem em um determinado ponto (solicitação pelo DG da ARA-CN)

Regarding the above, we conducted the following activities…

14

4 REPORT of FIELD from A to G

B. Características dos rios e bacias

[2] Actividades

a. Ter percepção sobre as características dos cursos dos rios e bacias a partir das imagens de satélite (Google Earth).
b. Orientação sore o método de cálculo utilizando GIS e planilha Excel.

Through the activities, C/P improved/obtained the followings…

15

4 REPORT of FIELD from A to G

B. Características dos rios e bacias

[3] Melhores conhecimentos e capacidades

Características

a. Aprendizagem da leitura das características dos rios e bacias a partir do Google Earth.

Volume armazenada de água numa barragem

a. Aquisição da capacidade de cálculo da relação elevação - volume armazenada de água numa barragem construída em um determinado ponto, usando GIS e planilha Excel.

After the Assistance, C/P will do the followings for next step…

16

4 REPORT of FIELD from A to G

B. Características dos rios e bacias

[4] Próxima ação

a. Aprofundar o entendimento sobre os rios e bacias através da acurada observação e análise das imagens de satélite, mapas topográficos e levantamentos in situ.

17

4 REPORT of FIELD from A to G

C. Medidas estruturais

[1] Problemas

a. Experiência de trabalho insuficiente para elaboração de medidas para as estruturas.

Regarding the above, we conducted the following activities…

18

4 REPORT of FIELD from A to G

C. Medidas estruturais

[2] Actividades

a. Realização do estudo de medidas para as estruturas dentro da elaboração do Plano de Gestão de Riscos de Inundação.

Through the activities, C/P improved/obtained the followings…

19

4 REPORT of FIELD from A to G

C. Medidas estruturais

[3] Melhores conhecimentos e capacidades

a. Compreensão das funções de cada estrutura, e a distribuição das instalações de acordo com essas funções.

After the Assistance, C/P will do the followings for next step…

20

4 REPORT of FIELD from A to G

C. Medidas estruturais

[4] Próxima ação

a. Desta vez o estudo foi realizado para sítios específicos. É necessário adquirir de forma continuada capacidades práticas pela realização de vários estudos considerando diversos outros sítios, rios e escalas de inundação.
b. Futuramente, chegar ao nível de poder avaliar os efeitos da construção dessas instalações através da análise de alagamentos e análise económica.

21

4 REPORT of FIELD from A to G

D. Sistema de Previsão e Alerta de Inundação

[1] Problemas

a. O intervalo de tempo entre a alerta dada e a subida do nível deágua é curto e não dá tempo para evacuação.

Regarding the above, we conducted the following activities…

22

4 REPORT of FIELD from A to G

D. Sistema de Previsão e Alerta de Inundação

[2] Actividades

a. Orientação sobre o Sistema de Alerta Precoce (Auto-IFAS).
b. Formação de treinadores hidrológicos.
c. Estudo das medidas aplicáveis e realização da orientação à Unidade Mocuba.

Through the activities, C/P improved/obtained the followings…

23

4 REPORT of FIELD from A to G

D. Sistema de Previsão e Alerta de Inundação

[3] Melhores conhecimentos e capacidades

a. Elaboração do modelo IFAS/ Auto-IFAS.
b. Obtenção da capacidade de previsão do nível de água com base no volume de precipitação observado (por satélite).
c. Graças a isso tornou-se possível emitir a alerta numa fase mais precoce do que antes.
d. Aquisição da capacidade de instruir sobre a elaboração dos modelos, a exercer a função de treinador hidrológico.
e. Entendimentos sobre a notificação dos dados de observação à DNGRH, procedimentos de emissão de alerta de acordo com os valores previstos pela DNGRH, etc.
f. Através desses estudos feitos chegou-se ao entendimento geral sobre o sistema de previsão e alerta, diferença temporal entre os picos de precipitação e de caudal (nível de água), diferença temporal na precipitação observada por satélite, etc.

After the Assistance, C/P will do the followings for next step…

24

4 REPORT of FIELD from A to G

D. Sistema de Previsão e Alerta de Inundação

[4] Próxima ação

a. Estabelecimento de uma estrutura de operação por 24 horas durante as épocas de chuva, principalmente em ocorrências de inundação.
b. Manter os registos feitos e revisá-los após cada ocorrência de cheias/ estação de chuvas, de modo a servirem de base de discussão sobre os momentos exactos de emissão de alertas e revisão de factores como nível de água, etc.
c. O treinador hidrológico exerce a função de orientador e realiza treinamentos sobre hidrologia, hidrálica e engenharia fluvial aos funcionários da DNGRH e das ARAs de modo a elevar a capacidade tecnológica básica da organização.
d. Aumentar a frequência de observação do nível de água nas estações de observação, principalmente em ocorrências de inundações. Observações a partir das 18 horas. Buscar realizar observações de hora em hora.
e. Not to overestimate the early warning system and to collect information and observe data during flood

25

4 REPORT of FIELD from A to G

(SKIP)

26

4 REPORT of FIELD from A to G

E. Fornecimento de informações sobre o desastre de fácil compreensão

[1] Problemas

a. As informações necessárias durante a ocorrência de inundação não estão disponíveis aos moradores.
b. Os gráficos de pluviograma e hidrograma emitidos diariamente no "Boletim Nacional de Hidrologia" são de difícil compreensão.

Regarding the above, we conducted the following activities…

27

4 REPORT of FIELD from A to G

E. Fornecimento de informações sobre o desastre de fácil compreensão

[2] Actividades

a. Foram feitas recomendações a respeito de informações sobre desastres que cada entidade deve fornecer, através de exemplos que apresentam conteúdos de fácil compreensão.
b. Haviam sido desenhados três curvas no hidrograma de nível de água, sendo uma da estação de chuva pertinente, e mais curvas do ano anterior e de 2 anos atrás. Foi recomendado exibir o nível de água do ano que registou máxima histórica em termos de nível de água, e deixar de exibir o nível de água de 2 anos atrás.

Through the activities, C/P improved/obtained the followings…

28

4 REPORT of FIELD from A to G

E. Fornecimento de informações sobre o desastre de fácil compreensão

[3] Melhores conhecimentos e capacidades

a. Entendimento sobre o tipo de texto que permite fácil compreensão às pessoas. Comparação com as grandes cheias do passado / Títulos curtos e objectivos / Recomendações em relação às acções que as outras entidades e as pessoas devem tomar
b. Em resposta à recomendação, foi alterada a exibição no referido Boletim. Foi feita a mesma alteração para a exibição na nova tela do monitor de dados hidrológicos que foi instalada.

After the Assistance, C/P will do the followings for next step…

29

4 REPORT of FIELD from A to G

E. Fornecimento de informações sobre o desastre de fácil compreensão

[4] Próxima ação

a. Após a ocorrência de uma inundação revisar o conteúdo e fazer melhorias se necessário.

30

4 REPORT of FIELD from A to G

F. Cadastro das Instalações de Controlo do Rio

[1] Problemas

a. As instalações sofrem frequentes danos devido à insuficiência de inspecções nas suas estruturas fluviais e no seu controlo e manutenção.

Regarding the above, we conducted the following activities…

31

4 REPORT of FIELD from A to G

F. Cadastro das Instalações de Controlo do Rio

[2] Actividades

a. Houve orientação para elaboração do Cadastro de Instalações de Controlo do Rio para que hajam os devidos controlos e manutenções.

Through the activities, C/P improved/obtained the followings…

32

4 REPORT of FIELD from A to G

F. Cadastro das Instalações de Controlo do Rio

[3] Melhores conhecimentos e capacidades

a. Através da discussão baseada nas investigações das situações actuais de cada instalação, houve aprendizados sobre as funções exigidas para cada uma delas e as causas dos acidentes, entre outros.
b. Aprendizado sobre a importância da inspecção e da manutenção periódicas para que a função das instalações possam desempenhar as suas respectivas funções.
c. Aquisição da capacidade em produzir o Mapa de Cadastro de Manutenção com base no Google Earth.

After the Assistance, C/P will do the followings for next step…

33

4 REPORT of FIELD from A to G

F. Cadastro das Instalações de Controlo do Rio

[4] Próxima ação

a. Implementação do Cadastro e a sua actualização continuada.
b. Usar o Cadastro para definir a prioridade dos reparos a serem feitos.
c. Desafio: ambiente de conexão à internet

34

4 REPORT of FIELD from A to G

G. Estrutura Organizacional/ Desenvolvimento de recursos humanos

[1] Problemas

a. Na DNGRH os responsáveis pelos trabalhos relacionados à inundação estão dispersos em diversos departamentos como a de Recursos Hídricos e Rios Internacionais.
b. Os treinamentos realizados pela DNGRH visam principalmente a questão de águas e esgoto e não incluem a gestão de riscos de inundação.
c. Todos os treinamentos dependem de financiamentos dos doadores.

Regarding the above, we conducted the following activities…

35

4 REPORT of FIELD from A to G

G. Estrutura Organizacional/ Desenvolvimento de recursos humanos

[2] Actividades

a. Foi recomendada a criação de uma divisão independente a se encarregar dos trabalhos de gestão de riscos de inundação.
b. Foi elaborado o programa de treinamento e Syllabus ligado à administração de rios, gestão integrada de riscos de inundação e treinador hidrológico.

Through the activities, C/P improved/obtained the followings…

36

4 REPORT of FIELD from A to G

G. Estrutura Organizacional/ Desenvolvimento de recursos humanos

[3] Melhores conhecimentos e capacidades

a. Criação de uma nova Unidade de Inundação e Seca.
b. Foi adquirido o programa de treinamento e Syllabus necessário para a melhoria das capacidades relacionadas à gestão de riscos de inundação.

After the Assistance, C/P will do the followings for next step…

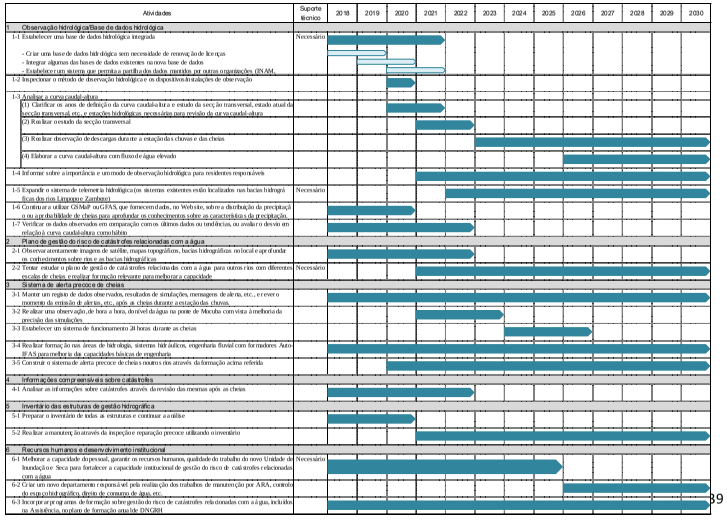
4 REPORT of FIELD from A to G

G. Estrutura Organizacional/ Desenvolvimento de recursos humanos

[4] Próxima ação

a. Capacitar tecnicamente, garantir pessoal e melhorar o conteúdo dos trabalhos da nova Unidade de Inundação e Seca que foi criada, e assim elevar a capacidade da organização.
b. Criar uma nova divisão responsável pela manutenção de modo a liderar os trabalhos de manutenção realizados pelas ARAs e também fazer o controlo do espaço fluvial e os direitos de utilização da água.
c. Incorporar o plano de treinamento elaborado no Plano de Treinamentos de toda a DNGRH.
d. A DNGRH deve tomar a iniciativa de realizar os treinamentos recomendados no presente trabalho, sem deixar o conteúdo dos treinamentos nas mãos dos doadores.

5 ACTION PLAN



Muito Obrigado

ASSISTÊNCIA
PARA
AMPLIÇÃO DA CAPACIDADE INSTITUCIONAL
PARA GESTÃO DE RISCOS DE DESASTRE RELACIONADOS COM ÁGUA
EM
MOÇAMBIQUE

Transferência de Tecnologia na Gestão do Rio

08 Dec. 2017
JICA Team

1

Principaís actividades durante o projecto

1. *Treinamento dos técnicos*
2. *Revisão dos dados hidrológicos*
3. *Aplicação de dados hidrológicos*
4. *Aplicação de informação por satélite*
5. *Aplicação do GIS na gestão de recursos hídricos*
6. *Desenvolvimento de modelos hidrológicos e hidráulicos*
7. *Formação de formadores*
8. *Previsão de inundaçõe e sistema de alerta prévio - Sistema AutoIFAS -*

2

1. Treinamento dos técnicos (1/3)

Foram ministrados 4 cursos

- Modelagem para análise de inundações (1º): 15 participantes, 10 dias
- Modelagem para Análise de Inundações (2º): 22 participantes, 10 dias
- Treinamento em IFAS e Auto IFAS (1º): 10 participantes, 10 dias
- Treinamento em IFAS e Auto IFAS (2º): 9 participantes, 9 dias

3

1. Treinamento dos técnicos (2/3)

1: Agosto de 2015: modelagem para análise de inundações (1º) na DNGRH (Maputo)

2: Agosto de 2015: modelagem para análise de inundações (2º) na ARA-CN (Nampla)

3: Outubro de 2016: IFAS e Auto IFAS T (1º) na DNGRH (Maputo)

4: Novembro de 2016: IFAS e Auto IFAS (2º) na DNGRH (Maputo)

4

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1. Treinamento dos técnicos (3/3)

- Manuais na versão em português -

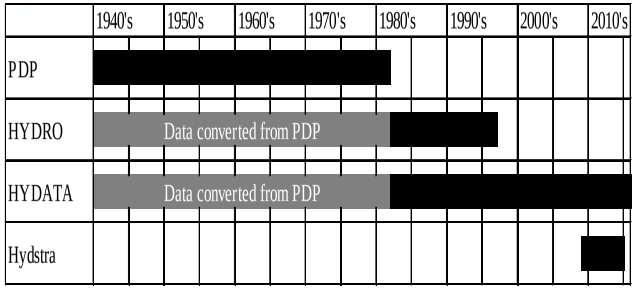
IFAS Quick Reference	IFAS (Ver.2.0) Manual Técnico	Manual de operação do AutoIFAS
		

Manuais e documentos de referência estão disponíveis no Google Drive compartilhado (https://drive.google.com/drive/folders/0B9mP2S0_MYRfY1RpMFpPR0NtbHM)

5

2. Revisão dos dados hidrológicos (1/4)

Período de Operacional dos Sistemas de Gestão de Dados Hidrológicos



6

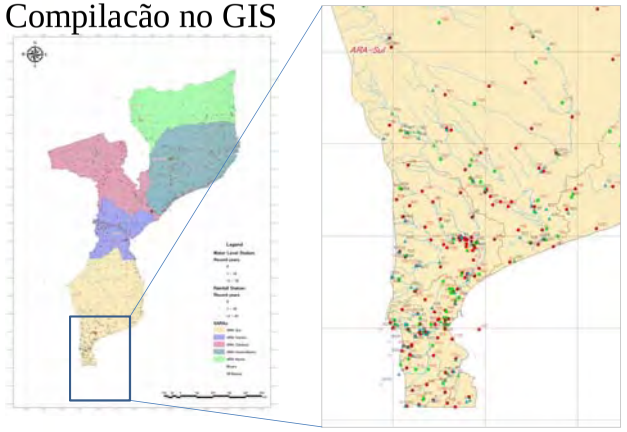
2. Revisão dos dados hidrológicos (2/4)

Atividade	Método	Saída
• Para esclarecer a localização da estação hidrológica.	• Revisão da lista de estações do Excel (precipitação, nível de água e descarga) • Conversão em formato de arquivo Shape usando o GIS • Conversão em formato de arquivo KML usando o GIS	• Mapa de localização da estação hidrológica • Arquivo de formato GIS • Arquivo KML para o Google Earth
• Revisão do estado de funcionamento das estações hidrológicas e a disponibilidados seus dados	• Pesquisa com base na entrevista sobre o estado da base de dados hidrológicos • Revisão da disponibilidade de dados hidrológicos digitalizados • Dados resumidos numa tabela	• Lista de arquivos de dados • Lista de estações com disponibilidade de dados

7

2. Revisão dos dados hidrológicos (3/4)

Compilacão no GIS



8

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2. Revisão dos dados hidrológicos (4/4)

9

3. Aplicação de dados hidrológicos (1/3)

Até Fevereiro de 2015

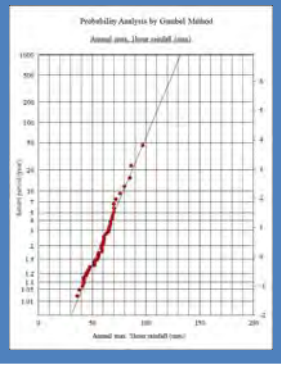
Resumo dos dados hidrológicos (estações)

No.	ARA	Chuva 1909~	Nível de água 1930~	Descarga 1930~
1	ARA Sul	300	181	133
2	ARA Centro	220	97	74
3	ARA Zambeze	353	131	46
4	ARA Centro-Norte	361	140	113
5	ARA Norte	114	71	52
	Total	1,348	620	418

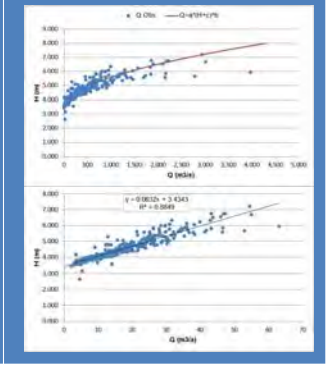
10

3. Aplicação de dados hidrológicos (2/3)

Análise estatística



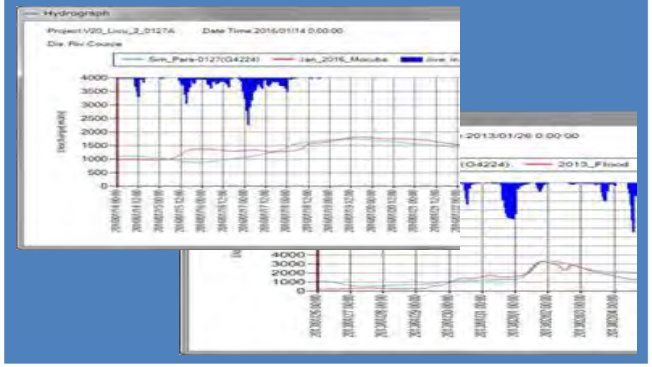
Curva de relação H-Q



11

3. Aplicação de dados hidrológicos (3/3)

Calibração do modelo



12

AP - 59

4. Aplicação de informação por satélite (1/3)

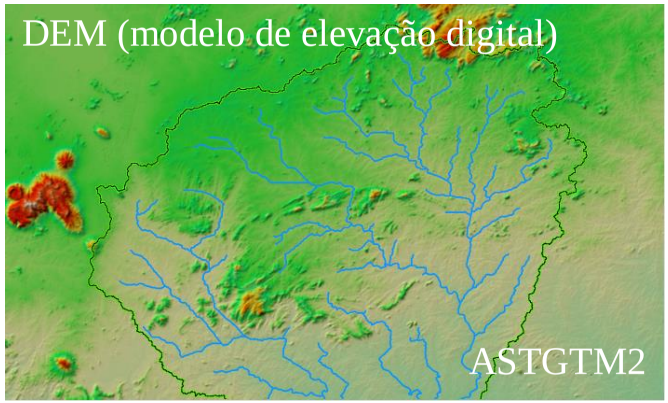
Imagem de satélite

Baixo Licungo, Cheias em 2015

http://earthobservatory.nasa.gov/IOTD/view.php?id=85145&src=ve

13

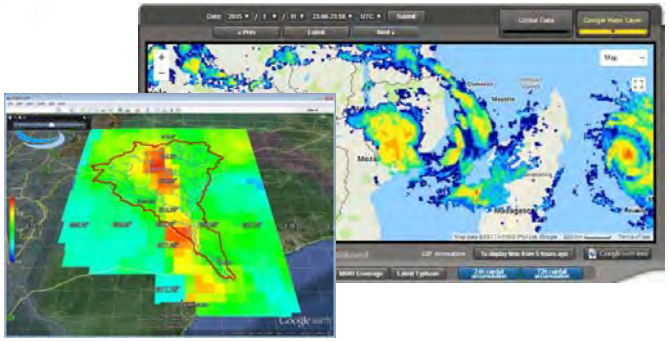
4. Aplicação de informação por satélite (2/3)



14

4. Aplicação de informação por satélite (3/3)

Precipitação Observada por Satélite

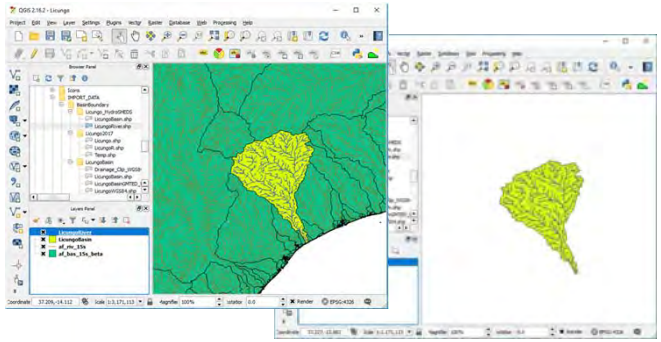


JAXA GSMaP (Global Satellite Mapping of Precipitation)

15

5. Aplicação do GIS na gestão de recursos hídricos (1/3)

QGIS



16

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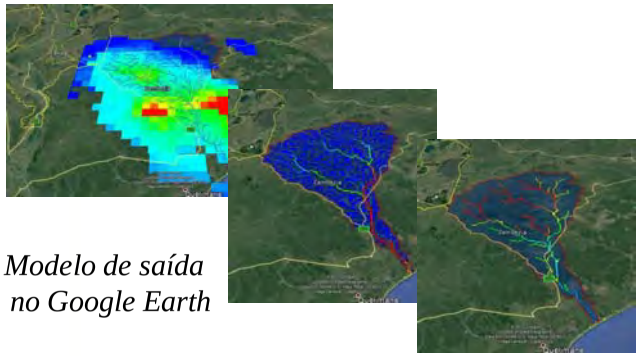
5. Aplicação do GIS na gestão de recursos hídricos (2/3)

Google Earth Pro

17

5. Aplicação do GIS na gestão de recursos hídricos (3/3)

Google Earth Pro



Modelo de saída no Google Earth

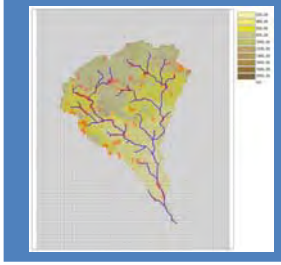
18

6. Desenvolvimento de modelos hidrológicos e hidráulicos (1/4)

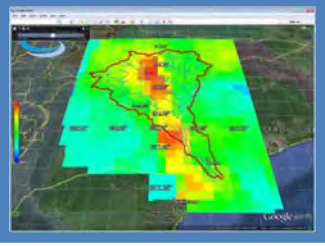
IFAS: Integrated Flood Analysis System

Sistema de Previsão de Inundações com Precipitação de Satélites Globais

Imagem modelo do IFAS



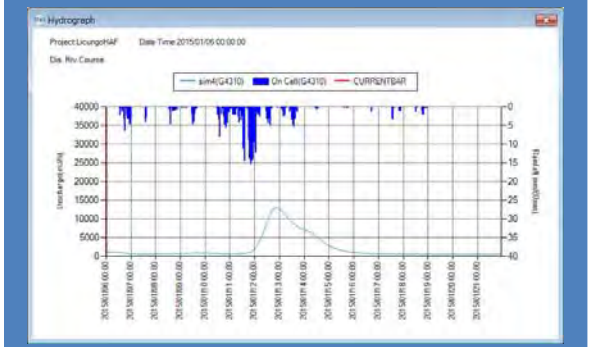
Entrada GSMaP (Global Satellite Mapping of Precipitation)



19

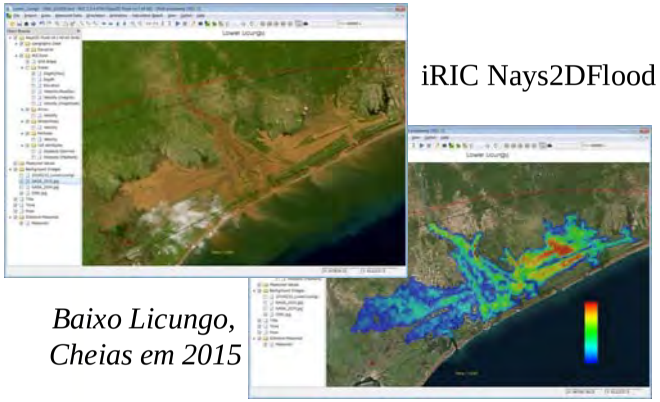
6. Desenvolvimento de modelos hidrológicos e hidráulicos (2/4)

Imagem de saída IFAS em Mocuba



20

6. Desenvolvimento de modelos hidrológicos e hidráulicos (3/4)



iRIC Nays2DFlood

Baixo Licungo, Cheias em 2015

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6. Desenvolvimento de modelos hidrológicos e hidráulicos (4/4)

- O modelo hidrológico e hidráulico é útil para a gestão dos resursos hídricos
- O desenvolvimento de um modelo preciso requer uma calibração adequada do mosmo, usando dados observados, como descarga, nível de água e chuvas.
- A verificacão e análise dos dados observados são são importantes para o desenvolvimento de um modelo.
- A gestão de dados hidrológicos também é importante para actividades de gestão de recursos hídricos.

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7. Formação de formadores (1/3)

Treinamento dos formadores para o sistema de aviso prévio de inundações AutoIFAS:

- 6 Participantes, 9 dias

Grupo alvo:

- Os candidatos a Treinadores devem possuir conhecimentos sólidos de Hidrológia e Hidráulica
- Gestores do sistema de aviso prévio de inundações AutoIFAS
- Especialistas na operacão e manutencão do Sistema de aviso prévio de inundações AutoIFAS

23

7. Formação de formadores (2/3)

Formação em Agosto de 2017 (Maputo)	Formação em Agosto de 2017 (Maputo)
	
Formadores a treinarem colegas (DNGRH / DGBH)	Formadores a treinarem colegas (DNGRH / DGBH)
	

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7. Formação de formadores (3/3)

Certificado

• *Formadores em Hidrológia e Hidráulica* • *Formadores no modelo IFAS e AutoIFAS*	*1) Sr. Agostinho Vilanculo* *2) Sr. José Alvaro Malanco* *3) Sr. Isac Filimone*
• *Formadores Assistentes em Hidrológia e Hidráulica* • *Formadores no modelo IFAS e AutoIFAS*	*4) Sr. Armando Cuinhane* *5) Sra. Filoca Fundo* *6) Sr. Leno Gomes*

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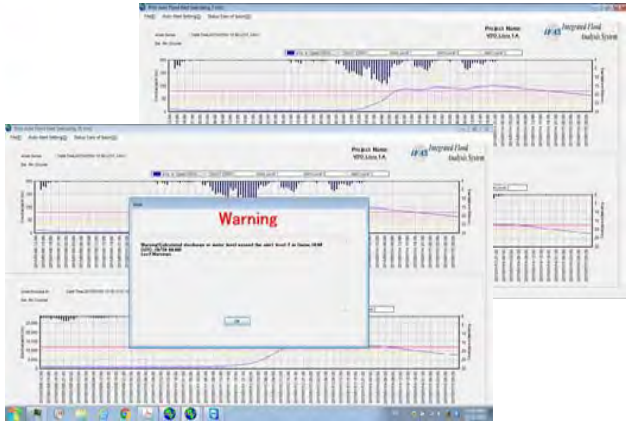
8. Previsão de inundação e sistema de alerta prévio - Sistema AutoIFAS - (1/3)

- Modelo IFAS para a Bacia do Licungo
- JAXA GSMaP NRT
  (Quase em Tempo Real: Atraso de 4 horas)
- Disponibilidade de dados: De hora em hora
- Nível de alerta 1: +6 m na estação de Mocuba
- Nível de alerta 2: +7 m na estação de Mocuba
- Nível de alerta 3: +8 m na estação de Mocuba

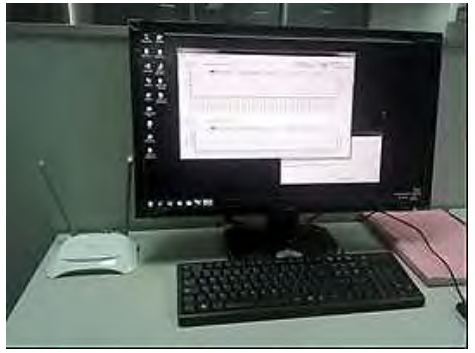
26

8. Previsão de inundação e sistema de alerta prévio - Sistema AutoIFAS - (2/3)



27

8. Previsão de inundação e sistema de alerta prévio - Sistema AutoIFAS - (3/3)



O sistema AutoIFAS da Bacia do rio Licungo a correr no DGBH.

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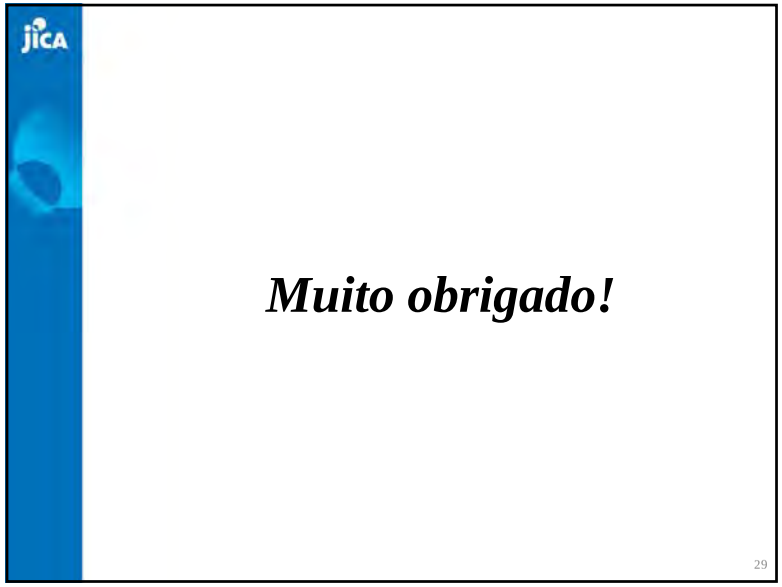

JICA
Muito obrigado!
29

República de Moçambique

REPÚBLICA DE MOÇAMBIQUE

IFAS – Modelo Hidrológico

Maputo, 08 de Dezembro de 2017

República de Moçambique

CONTEÚDO DA APRESENTAÇÃO

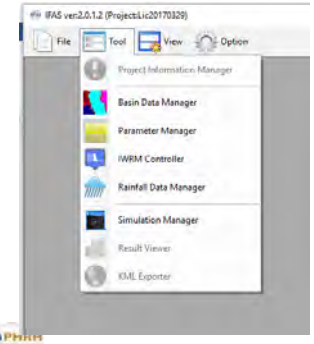
1. **MODELO HIDROLÓGICO IFAS**
   - Conceito
   - Dados de Entrada
   - Resultados
2. **MODELO AUTOMATICO AUTO IFAS**

República de Moçambique

MODELO HIDROLOGICO IFAS

CONCEPÇÃO DO MODELO

- O IFAS – *Sistema Integrado de Análise de Cheias;*
- Produzido pela ICHARM, é uma ferramenta de análise e previsão de escoamento com interfaces para a entrada de dados de precipitação baseados em satélite e/ou da rede manual, destinada basicamente à países com poucos recursos.



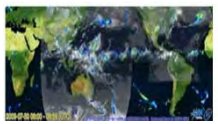
República de Moçambique

MODELO HIDROLOGICO IFAS

DADOS DE ENTRADA

- **Barragens**
- **Calibração**
- **Curva de Vazão**

Topográficos Uso/Cobertura B. Hidrográfica Parâmetros



Precipitação Baseada em Satélite
•Disponibilizado pela JAXA
(Global Satellite Mapping of Precipitation)
•Atraso de 4 horas

República de Moçambique

MODELO HIDROLOGICO IFAS

DADOS DE ENTRADA:
- Topográficos
- Uso/Cobertura
- Bacia Hidrográfica



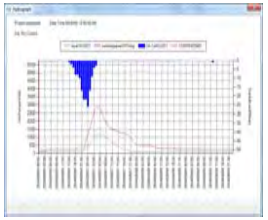
PARÂMETROS:
- Barragens
- Calibração
- Curva de Vazão

Modelo IFAS

IFAS

DADOS DE ENTRADA:
- Precipitação

RESULTADOS:
- Níveis Hidrométricos
- Caudais



República de Moçambique

MODELO HIDROLOGICO AUTO IFAS

Download automático
dados de precipitação

IFAS

AUTO IFAS

RESULTADOS:
- Níveis de Alerta
- Caudais de Alerta

República de Moçambique

MODELO HIDROLÓGICO IFAS

APLICAÇÃO/VANTAGENS

Em bacias sem ou com pequenas barragens, por exemplo:
- *Bacia do Púngoè*
- *Sub Bacias do Zambeze (Luia, Revubue, Luenha, Chire, etc.)*
- *Bacia de Melela*
- *Bacia do Messalo*
- *Bacia do Montepuez*

Simplicidade do Modelo
- *Não requer muitos dados*
- *Não requerer computador robusto*

Não requer Licença

Sistema de Alerta via Email

DESVANTAGENS:
- Requer internet permanente;
- Um modelo para um computador (AutoIFAS)

DESAFIOS
- Setup de Barragens
- Calibração do Modelo

República de Moçambique

MODELO HIDROLÓGICO IFAS

PASSOS SUBSEQUENTES:

•Continuar a aperfeiçoar o Modelo IFAS na DNGRH
•A DNGRH deve capacitar as outras ARAs no uso do Modelo


República de Moçambique
MOPHRH
Por uma Gestão Integrada e Sustentável dos Recursos Hídricos
OBRIGADO PELA ATENÇÃO!
MOPHRH

REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DAS OBRAS PÚBLICAS, HABITAÇÃO E RECURSOS HÍDRICOS

ARA-Centro Norte

UNIDADE DE GESTÃO DAS BACIAS DO OESTE - UGBO

FLUXO DE INFORMAÇAO NA EPOCA CHUVOSA

Mocuba, Dezembro de 2017

CONTEÚDOS

- BREVE HISTORIAL
- APOIO INSTITUICIONAL
- CAPACITAÇAO/FORMAÇAO
- SISTEMA DE AVISO PREVIO DE CHEIAS
- FLUXO DE INFORMAÇAO NA EPOCA CHUVOSA
- COMUNICADO DE IMPRESA

BREVE HISTORIAL

Em Janeiro de 2015 a intensidade das chuvas torrenciais causaram o transbordamento do rio Licungo, na Zambézia, afectando sobre tudo os distritos de Mocuba, Maganja da Costa e Namacurra, causando a perdas de vidas humanas, destruição de bens da população e infra-estruturas socioeconómicas.

APOIO INSTITUICIONAL

No âmbito das relações de cooperação bilateral entre a Republica de Moçambique e o Governo do Japão, a Direção Nacional de Gestão de Recursos Hídricos (DNGRH) a implementou um Projecto de Assistência para Apoio da Capacidade Institucional na Gestão dos Riscos de Desastres Relacionados com água no Pais, cujo numa primeira fase a Bacia do rio Licungo, na província da Zambézia foi selecionada como Piloto para implementar o Projecto.

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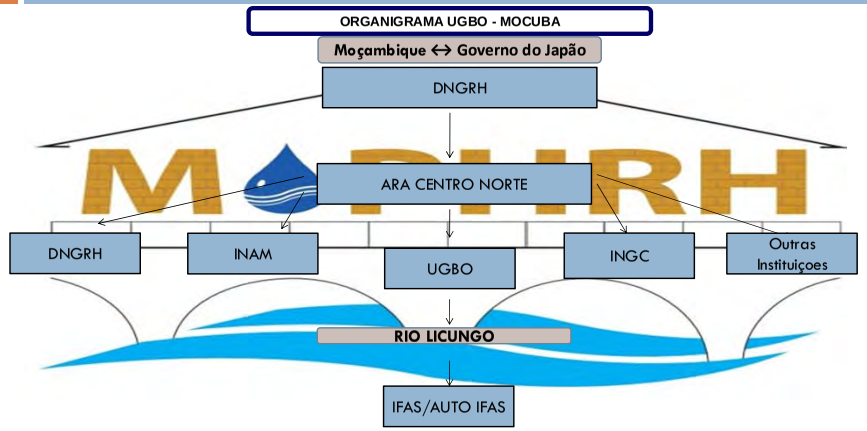
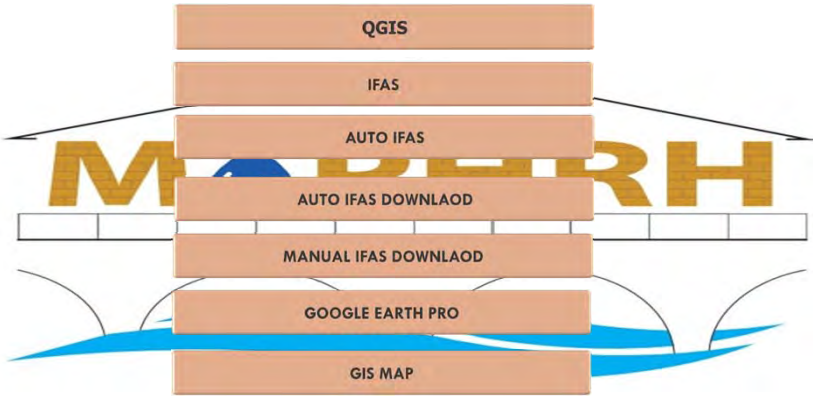
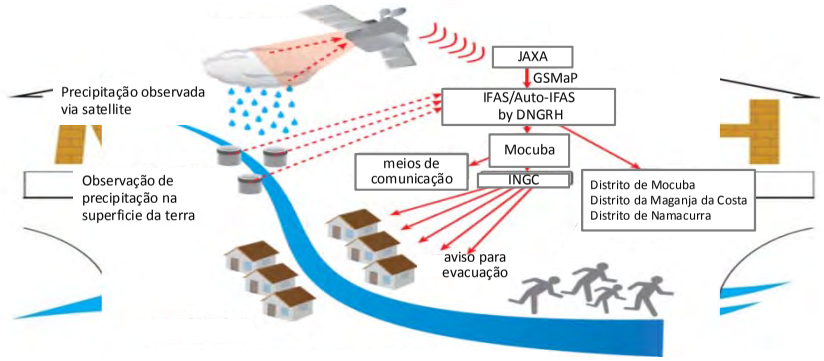
APOIO INSTITUICIONAL



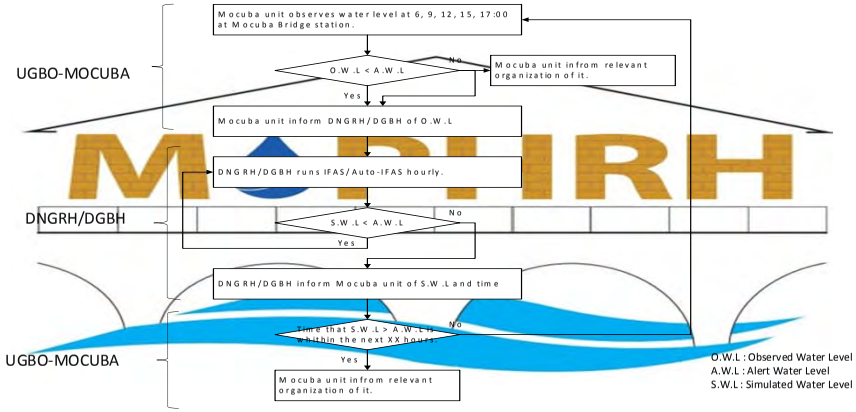
CAPACITACAO/FORMAÇAO

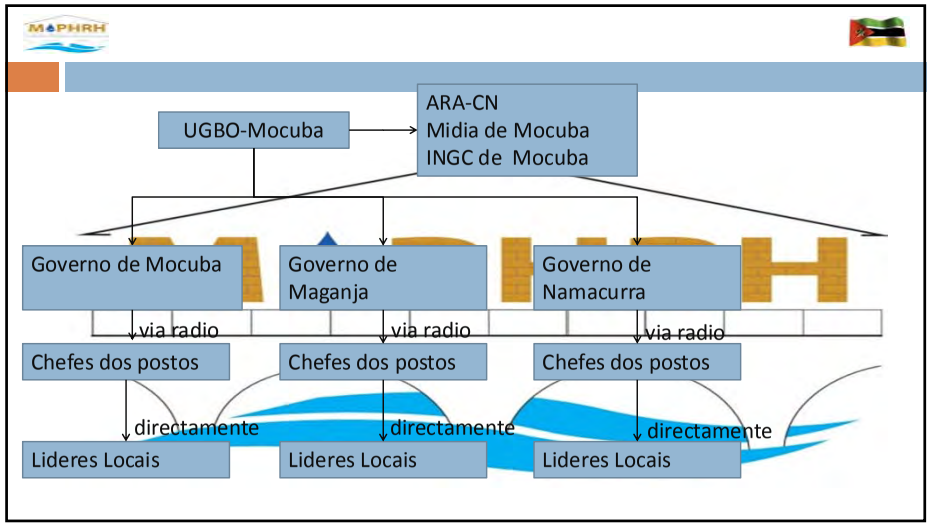


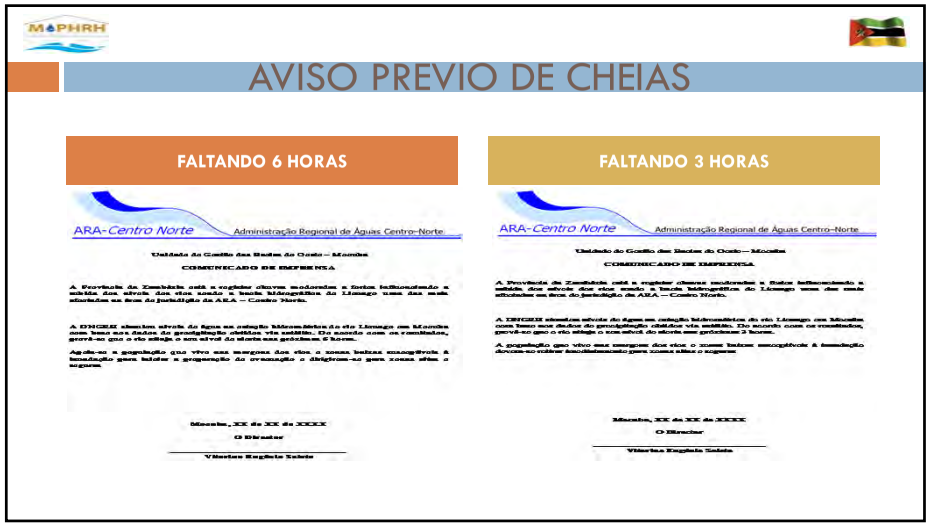
SISTEMA DE AVISO PREVIO DE CHEIAS



fluxo de informacao na epoca chuvosa




UGBO-Mocuba
ARA-CN
Midia de Mocuba
INGC de Mocuba
Governo de Mocuba
Governo de Maganja
Governo de Namacurra
via radio
via radio
via radio
Chefes dos postos
Chefes dos postos
Chefes dos postos
directamente
directamente
directamente
Lideres Locais
Lideres Locais
Lideres Locais


AVISO PREVIO DE CHEIAS
FALTANDO 6 HORAS
FALTANDO 3 HORAS
ARA-Centro Norte
Administração Regional de Águas Centro-Norte
ARA-Centro Norte
Administração Regional de Águas Centro-Norte


POR UMA GESTÃO INTEGRADA E PARTICIPATIVA
DE RECURSOS HÍDRICOS
OBRIGADO PELA ATENÇÃO
MOPHRH

AP - 70

REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DAS OBRAS PÚBLICAS, HABITAÇÃO E RECURSOS HÍDRICOS

ARA-Centro Norte

UNIDADE DE GESTÃO DAS BACIAS DO OESTE - UGBO

INVENTARIO DE ESTAÇÕES HIDROCLIMATOLOGICAS E INFRA ESTRUTURAS

Mocuba, Dezembro de 2017

- CONCEITO
- IMPORTANCIA
- VANTAGENS
- CONDICOES PARA CRIAR INVENTARIO
- PASSOS PARA CRIAR INVENTARIO

INVENTARIO

Inventario das estações consiste no mapa de estações com a despectivas coordenadas e informação sobre a situação das estações

IMPORTANCIA.

- Permite nos elaborar um mapa de estações e infra estruturas;
- Permite- nos saber a situação de operacionalidade de estações ou infraestruturas;
- Fazer a manutenção de estações e infraestruturas;
- Ter uma base de dados com informações relevantes;
- Desenhar trajetórias para chegar a um determinado local.
- Saber a transitabilidade das vias de acesso.

VANTAGENS

- Permite fazer atualizações continuas;
- É de fácil manuseio

CONDICÕES PARA ELABORAR INVENTARIO

- Ter um computador
- Estar ligado a Internet
- Instalar o GOOGLE EARTH PRO

Passos Para criar um Inventario

1. Abrir o Google Earth

a) selecionar ( ) botão no menu de ferramentas.

a) Direcionar o botão para o local desejado e gravar (E-91)

Passos Para criar um Inventario

2. Gravar com o formato KML

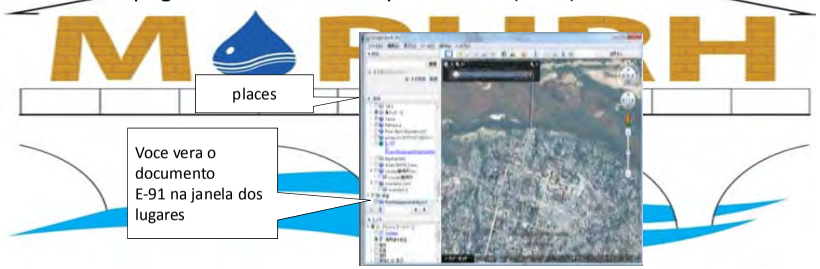
a) Com o curso posicionado no nome E-91 clica do lado direito do mauser , escolhe a opção save as places, e muda o formato do documento para KML, clica ok.

Passos Para criar um Inventario

3. Visualizar o documento gravado

a) Fechar o Google earth sem gravar

b) Ir na pasta inventario e abrir o documento gravado no formato KML, e apagar o instrumento experimental (KMZ)

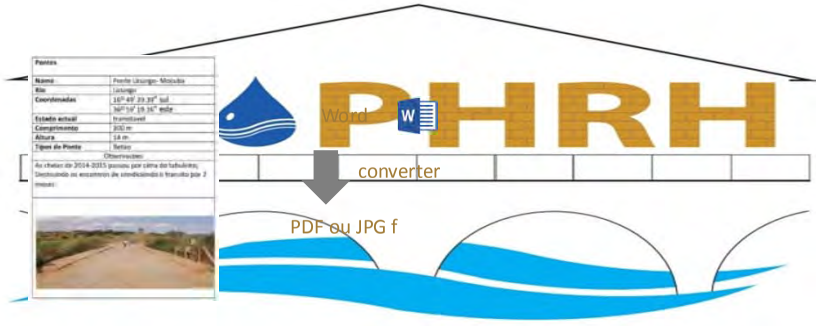


Passos Para criar um Inventario

4. Preparar informação para o inventario no word

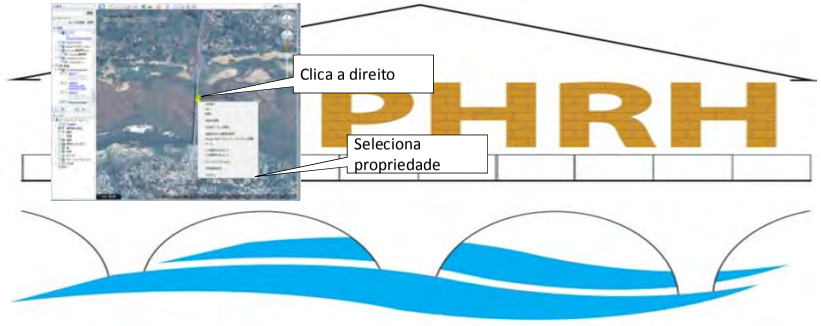
Passos Para criar um Inventario

4. Preparar informação para o inventario no word



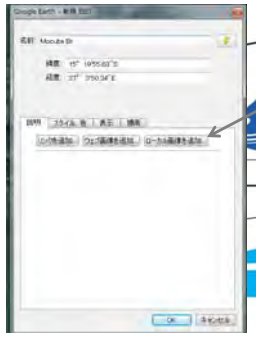
Passos Para criar um Inventario

5. Anexar a folha de inventario ao local marcado



Passos Para criar um Inventario

5. Anexar a folha do inventario ao local marcado



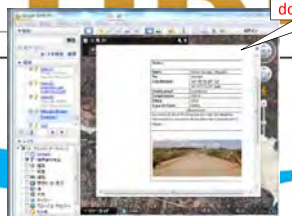
- Clicar em adicionar imagem".
- Selecionar a imagem da folha de inventario.
- Clicar "OK"

Property dialog-box

Passos Para criar um Inventario

6. Para visualizar a folha de inventario, posicione o curso na marca do ponto E-91, clica do lado direito do mauser, ou escolhe a opção abrir nova janela

Se deseja visualizar a folha do inventario clique na marca do lado esquerdo



Obrigada pela atenção

Assistência para o Fortalecimento Institucional das Capacidades de Gestão dos Riscos de Desastres relacionados com Agua

Importância da promover da redução do risco de desastres (RRD) pelas autoridades nacionais e locais

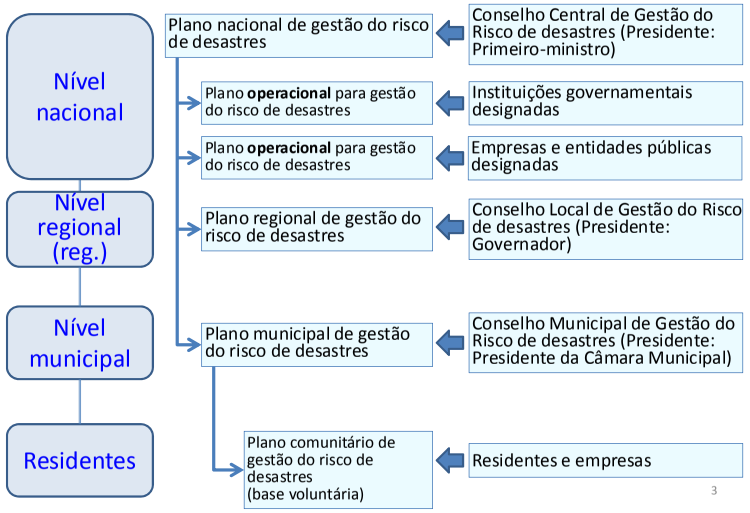
dezembro de 2017

Noritoshi MAEHARA
Experto no Desenvolvimento Institucional
Equipa da JICA

Conteúdo

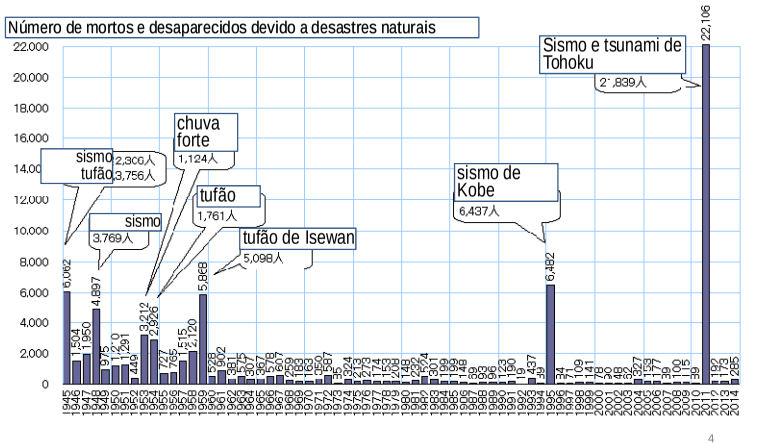
1. Descrição do sistema de gestão de desastres no Japão
2. Integração da RRD em todos os setores de desenvolvimento
3. Funções das autoridades nacionais e locais na redução do risco de desastres
4. Plano de contingência (resposta) e plano de redução do risco de desastres (RRD)
5. Atribuição de orçamentos para RRD a nível municipal
6. Conclusão

Descrição do sistema de gestão de desastres no Japão



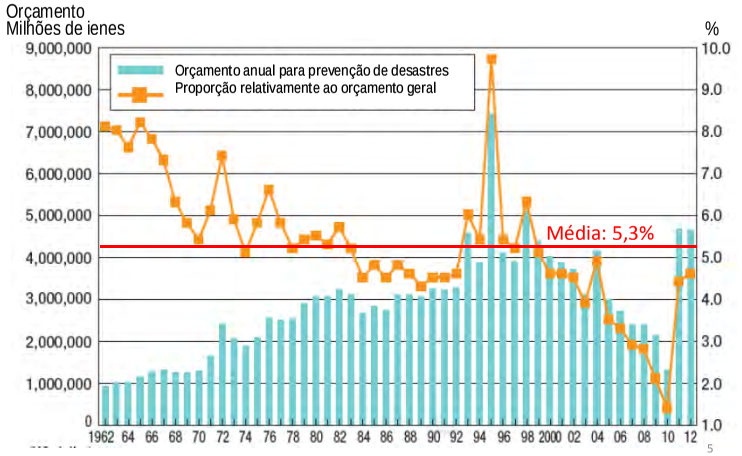
Integração da RRD em todos os setores de desenvolvimento

Importância do investimento na redução do risco de desastres (RRD)



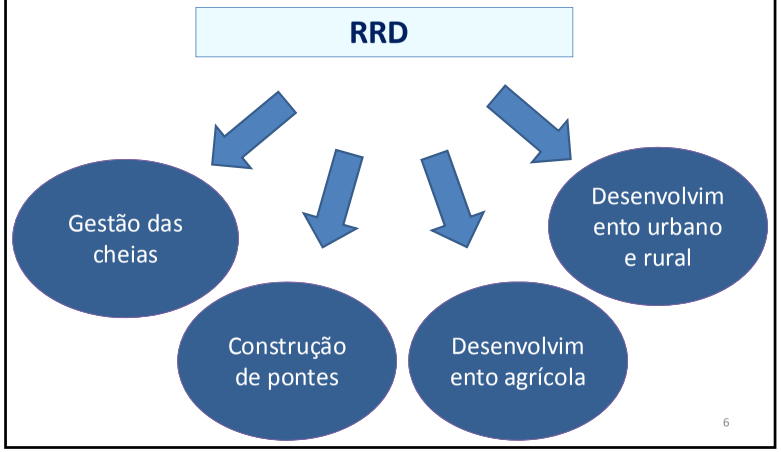
Integração da RRD em todos os setores de desenvolvimento

Orçamento anual para prevenção de desastres no Japão



Integração da RRD em todos os setores de desenvolvimento

Investimento para RRD

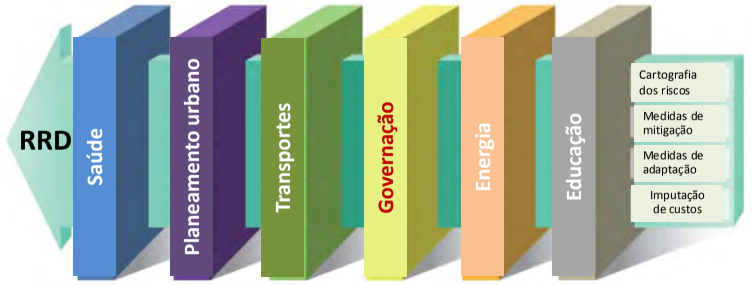


Integração da RRD em todos os setores de desenvolvimento

Ponte danificada devido a cheias em Jacarta, Indonésia

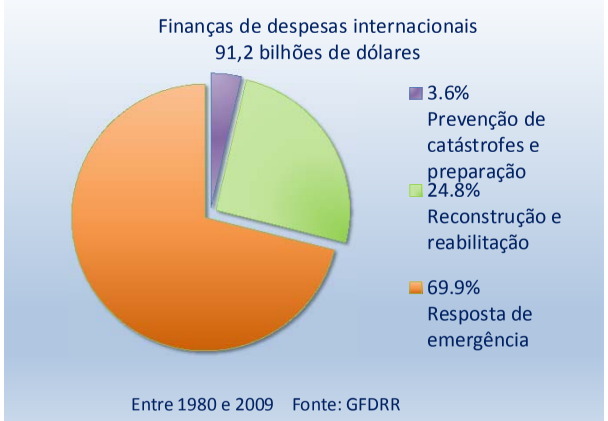
Bacias de retenção de cheias com recurso a arrozais em Niigata, Japão

Integração da RRD em todos os setores de desenvolvimento



Integração da RRD em todos os setores de desenvolvimento

Despesas internacionais com desastres



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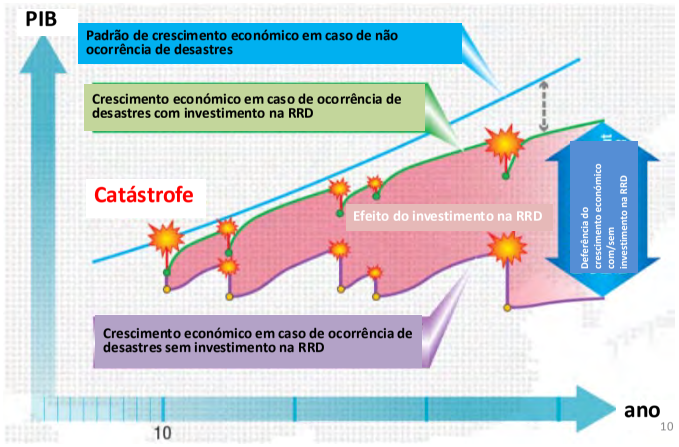
Integração da RRD em todos os setores de desenvolvimento

Investimento na RRD e no desenvolvimento económico



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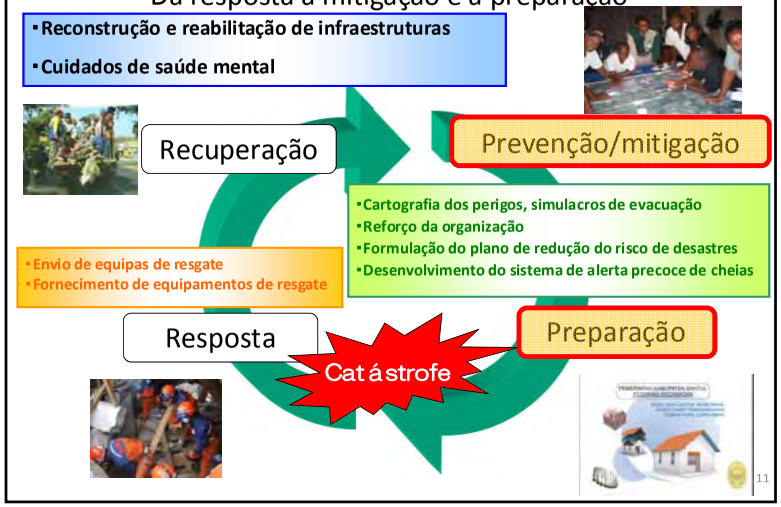
Ciclo de RRD
Da resposta à mitigação e à preparação



11

Sete (7) Metas do Framework Sendai para Redução do Risco de Desastres (RRD)

(a) Reduzir substancialmente a mortalidade global causada por catástrofe naturais até 2030

(b) Reduzir substancialmente o número de pessoas afetadas globalmente até 2030

(c) Reduzir a perda econômica direta devido a desastres em relação ao produto interno bruto global (PIB) até 2030

(d) Reduzir substancialmente os danos causados por desastres às infra-estruturas socio-economicas e a interrupção dos serviços básicos até 2030

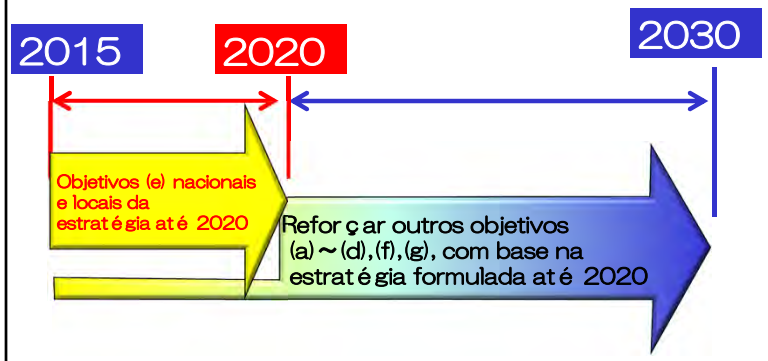
(e) Aumentar substancialmente o número de países com estratégias nacionais e locais de redução de risco de desastres até 2020.

(f) Melhorar substancialmente a cooperação internacional para os países em desenvolvimento para a implementação deste quadro até 2030

(g) Aumentar substancialmente a disponibilidade e o acesso aos sistemas de alerta precoce de riscos múltiplos até 2030

12

Quadro de ação de Sendai para objetivos de RRD



Funções das autoridades nacionais e locais nos planos de RRD e respetiva implementação

Tipo de perigo	Autoridades nacionais		Autoridades locais (município)
	Compreensão dos riscos	Medidas	Medidas
Comuns	Observação, cartografia dos perigos	Alerta precoce, plano de ocupação dos solos	Observação, ordem de evacuação, rotas, instalações, plano de ocupação dos solos
Cheias	Análise de cheias/inundações	Reservatórios/bacias de retenção, diques	Mapa de evacuação, combate às cheias, gestão do risco de desastres com base na comunidade
Sismo	Nível de abalo do solo	Código de construção, sistema de adaptação	Licença de construção
Tsunami	Área de inundação	Esporão	Mapa de evacuação
Deslizamento de terras	Declives perigosos	Proteção de declives	Alerta precoce, regulamentação da ocupação dos solos
Plano de RRD	Plano nacional de RRD		Plano local de RRD

Plano de contingência (resposta) e plano de redução do risco de desastres (RRD)

Plano de contingência (resposta)

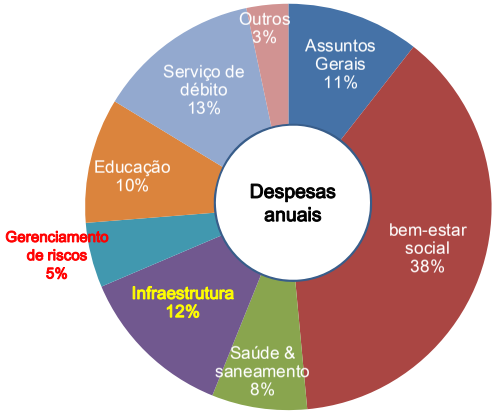
Objetivo
Plano de resposta de emergência antes, durante e depois de desastres

Plano de redução do risco de desastres (RRD)

Objetivo
Plano de investimento na prevenção e mitigação de desastres

Atribuição de orçamentos para RRD a nível municipal (cidade de Konosu)

Orçamento geral da cidade de Konosu em 2017: ±312 milhões de dólares



Orçamento para gestão do risco

Rubrica	Orçamento (1000 dólares)	Rácio	Observações
1. Defesa contra incêndios	14 187	88,1%	
2. Apoio para voluntários no combate aos incêndios	649	4,0%	
3. Equipamento de defesa contra incêndios	356	2,2%	
4. Gestão do risco de desastres	916	5,7%	
(4-1) Instalações e material para DRM	(187)	(1,2%)	
(4-2) Simulacros de desastres e campanhas de sensibilização	(45)	(0,3%)	
(4-3) Grupo de DRM voluntário	(44)	(0,3%)	
(4-4) Sistema de rádio para DRM	(178)	(1,1%)	
(4-5) Mão de obra e outros	(446)	(2,8%)	
TOTAL	16 107		

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Assistência para reforço da capacidade institucional de gestão dos riscos de desastres relacionadas com a água em Moçambique

Assistência para reforço da capacidade institucional de gestão dos riscos de desastres relacionadas com a água em Moçambique

Atribuição de orçamentos para RRD a nível municipal (cidade de Konosu)

Orçamento geral da cidade de Konosu em 2017: ±312 milhões de dólares

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Assistência para reforço da capacidade institucional de gestão dos riscos de desastres relacionadas com a água em Moçambique

Orçamento para desenvolvimento de infraestruturas

Rubrica	Orçamento (1000 dólares)	Rácio	Rubricas de RRD
1. Gestão de infraestruturas	2,364	6,2%	Aprovação de construções, incentivo aos trabalhos de reforço do desempenho sísmico de edifícios antigos, etc.
2. Estradas e pontes	6,836	17,8%	Limpeza dos sistemas de escoamento rodoviários
3. Gestão hidrográfica	178	0,5%	Gestão das cheias, melhoria do escoamento de águas, etc.
4. Planeamento urbano	29,040	75,6%	Planeamento urbano, desenvolvimento e gestão de sistemas de esgotos, etc.
5. Alojamento	596	1,6%	-
TOTAL	38,418		

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Conclusão

1. O Japão reduziu o número de vítimas de desastres através do investimento na redução do risco de desastres (RRD).
2. Todos os setores de desenvolvimento devem incluir a RRD nas respetivas medidas (integração da RRD).
3. Para evitar a perda de vidas e danos materiais, é importante o investimento na prevenção/mitigação e preparação.
4. De acordo com os objetivos acordados no Quadro de ação de Sendai para RRD, as autoridades nacionais e locais devem preparar planos de redução do risco de desastres (RRD).
5. As autoridades locais devem também elaborar um plano de redução do risco de desastres e garantir o orçamento para a respetiva implementação.
6. O papel, a responsabilidades, e competencias tecnicas das instituições como a DNGRH, ARAs, INAM e INGC sao muito importante para promover da redução do risco de desastres.

Appendix 1-4

Presentation for DG Meeting

ASSISTÊNCIA
AO
FORTALECIMENTO DA CAPACIDADE INSTITUTIONAL PARA
GERIR DESASTRES RELACIONADOS COM A AGUA
EM
MOÇAMBIQUE

24 de Maio de 2016
JICA Team Makoto KODAMA

1. CONTEXTO

Nos últimos anos, os investimentos visando o desenvolvimento para o crescimento económico em Moçambique aceleraram-se muito. Por outro lado, o risco de desastres naturais e os seus danos aumentaram por causa das mudanças climáticas, das actividades de desenvolvimento dos países vizinhos, actividades domésticas, etc.

Em mais, a lei de gestão dos desastres foi estabelecida em Junho de 2014 depois de uma longa deliberação e o reconhecimento da importância da gestão dos desastres.

A JICA e a DNA discutiram as componentes do projecto e confirmaram a necessidade de um fortalecimento institucional para fazer face aos desastres relacionados com a agua. Por fim, as duas organizações assinaram uma minuta de discussão (MD) mudando o nome do projecto para: Assistência ao Fortalecimento da Capacidade Institucional na Gestão dos Riscos de Desastres Relacionados com Agua em Moçambique.

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2. PERFIL DA ASSISTÊNCIA

Objectivo Geral

- Assistência Para o Reforço da Capacidade Institucional para Gerir Riscos de Desastres Relacionados com a Água em Moçambique

Objectivo:

- A DNA e outras organizações relacionadas desenvolvem um plano de gestão de desastres relacionado com agua.
- A DNA e as ARAs melhoram as capacidades de gestão das bacias hidrográficas.

C/P

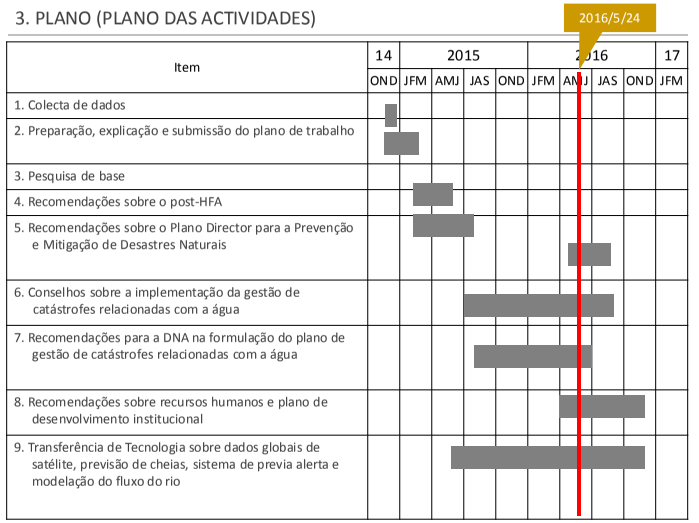
Agencia de Implementação: DNA, ARAs
Agencia Relacionas: MFE, INGC, INAM, ANE, DNHU, DNAPOT, MTARD, MINAG

Duração

Novembro de 2014 - Março de 2017 (cerca de 27 meses)

3

3. PLANO (PLANO DAS ACTIVIDADES)



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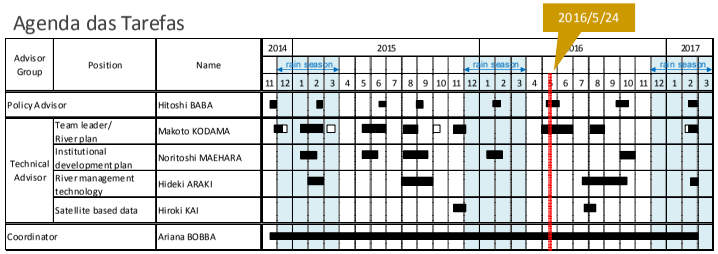
3. AGENDA (AGENDA das TAREFAS)

Agenda das Tarefas



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4. ACTIVIDADES PRINCIPAIS

4.1 Pesquisa de base

4-2 Recomendações sobre o Post-HFA

4-3 Recomendações sobre o Plano Director para a Prevenção e Mitigação de Desastres Naturais

4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

4-5 Recomendações para a DNA na formulação do plano de gestão de catástrofes relacionadas com a água

4-6 Recomendações sobre recursos humanos e plano de desenvolvimento institucional

4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

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4.1 Pesquisa de base

(1) Objectivo

- Compreender informações fundamentais sobre a gestão de desastres relacionados com a água em Moçambique.
- Compartilhar a consciência comum dos problemas relacionados com a gestão de rios

(2) Metodologia

- Colecta de dados e entrevistas
- Organização do workshop sobre a Gestão do Ciclo de Projecto (GCP) e Scenario-driven Tabletop Exercise para a revisão da cheia de 2015

7

4.2 Pesquisa de base

(3) Resultados da pesquisa de base

Actividades de redução do risco de desastres enfocadas na assistência

Item	Actividades
1. Utilização dos dados hidrologicos	• Reformular as estações de observação hidrológica (especialmente o estado de funcionamento) • Fazer o controle de qualidade pelas unidades da estações não perto da DNA • Compartilhar dados hidrológicos entre DNA / ARAs e INAM
2. Gestão da Estructura do Rio	• Fazer uma revisão do inventario das estructuras • Preparar o inventario das estruturas do rio usando o GIS
3. Gestão do risco de cheia	• Desenvolver EWS usando dados de precipitações do satelíte • Construir modelos de simulação de cheia • Desenvolver o plano de gestão de cheia
4. Desenvolvimento dos recursos humanos	• Desinhar o treinamento do curricula de gestão de rio

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4. ACTIVIDADES PRINCIPAIS

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4-2 RECOMENDAÇÕES SOBRE O POST-HFA

(1) Sendai Framework para a RRD

- Seminário sobre o HFA e o Post*-HFA Zero-draft antes da 3ª Conferencia Mundial sobre a RRD (WCDRR)
- Seminário sobre o Framework de Sendai sobre a RRD depois da 3ª

(2) Visita de Estudo no Japão (3ª WCDRR)

- Participação na 3ª Conferencia Mundial de RRD em Sendai, Japão
- Palestra do Ministério da Terra, Infra-estrutura, Transporte e Turismo (MLIT)
- Palestra sobre a observação e previsão meteorológica da Agencia Meteorológica do Japão (JMA)
- Visita de Campo na ponte de Ajuste de Arakawa

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4. ACTIVIDADES PRINCIPAIS

4.1 Pesquisa de base

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4-4 Recomendações sobre a Gestão de Desastres relacionados com a Água

(1) Seminários sobre a Gestão de Desastres relacionados com a Água

(2) Visita de Estudo no Japão

(3) Conselhos sobre os Sistemas de Gestão de Rios

(4) Distribuição da Informação de fácil compreensão sobre desastres

12

(3) Conselhos sobre Sistemas de Gestão de Rio

- Preparação do inventário das estruturas de gestão de rio para a manutenção dessas funções.
- Deve ser estabelecido um sistema sustentável e um método para a gestão do rio utilizando o inventário.

(3) Conselhos sobre Sistemas de Gestão de Rio

Preparação do inventá rio para a manutenção dessas fu

Esta actividade irá continuar durante o próximo ano

(4) Distribuição da Informação de fácil compreensão sobre Desastres

Lei de Gestão de Desastres N. 15/2014

Artigo 6 (Prevenção)

- 2. O Governo regula o controlo das bacias hidrográficas e o sistema eficaz de aviso prévio que permita a monitoria e prevenção de fenómenos hidro meteorológicos que possam causar calamidades.

Artigo 15 (Sistema de aviso prévio)

- 2. O aviso prévio pode ser local ou nacional, conforme a área territorial abrangida pélo risco de ocorrência da calamidade.

(4) Distribuição da Informação de fácil compreensão sobre Desastres

Recomendações

- Recomendações para a emissão da ordem de evacuação
- Expressões com sentido de emergência
  Por exemplo,
  - - "Uma inundação maciça que nunca temos experimentado nos últimos anos"
  - - "Uma inundação severa que é comparável com aquela da inundação de 2015"
  - - "Fortes chuvas que nunca temos experimentado nos últimos anos"
  - - "Um ciclone forte mais forte do que o ciclone Funso em 2012"
- Titulo do Comunicado
- Recomendação de implantar a UNAPROC (desde a DNA para o CENOE)
- Não usar termos técnicos como Alerta vermelha na radio comunitária

Esta actividade irá continuar durante o próximo ano

4. ACTIVIDADES PRINCIPAIS

4.4 Pesquisa de base

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4.5 Recomendações na formulação do plano de gestão de catástrofes relacionadas com a água

A equipa da JICA tem apoiado a DNA / ARAs para formular o plano de gestão de desastres no rio Licungo. O plano será preparado como mostra o fluxo seguinte. As actividades de algumas componentes do fluxo foram realizadas na Assistência, como no sistema de previa alerta de inundação, a informação de desastre, precipitação por satélite, etc.

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4.5 Recomendações na formulação do plano de gestão de catástrofes relacionadas com a água

Esta actividade irá começar no próximo ano

1. Entender a condição actual de uma bacia hidrográfica
2. Estudar medidas estruturais
3. Avaliar as opções de medidas estruturais
4. Considerar medidas não-estruturais
5. Estabelecer e determinar um plano de gestão dos riscos de inundações
6. Manter estruturas de gestão dos rios

Fluxo de Formulação para um Plano de Gestão Integrada das Cheias

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4. ACTIVIDADES PRINCIPAIS

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4-6 Recomendações sobre recursos humanos e plano de desenvolvimento institucional

Situação Actual

Em acordo com os treinamentos actuais da Divisão de Recursos Humanos, quase todos são em abastecimento de água e saneamento para engenheiros e técnicos da DNA, ARAs e pessoal do governo nacional e distrital.

↓

No período sucessivo

A Equipa da JICA irá propor planos de formação em gestão de riscos de desastres relacionados com a agua

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4. ACTIVIDADES PRINCIPAIS

4.4 Pesquisa de base

4-2 Recomendações sobre o Post-HFA

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4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

(1) Gestão de Dados Hidrológicos

(2) Modelação de Rio

(3) Previsão de Cheia e Sistema de Previa Alerta

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4-7 Transferência de Tecnologia sobre dados globais de satélite, previsão de cheias, sistema de previa alerta e modelação do fluxo do rio

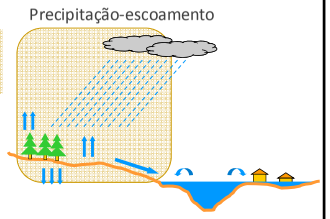
(2) Modelação de Rio

Modelo de analise de precipitação-escoamento

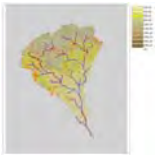
Chuvas em uma área de influência

↓

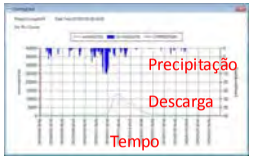
Descarga no ponto (Q)



IFAS (Integrated Flood Analysis System)



Modelo de um Sistema de Rio



Perfil da analise

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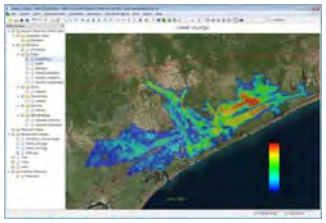
(2) Modelação de Rio

Modelo de analise do fluxo de cheia

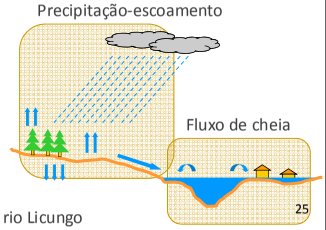
Descarga na extremidade superior no ponto calculado (Q) do rio

↓

- Nível de agua e descarga em qualquer ponto do rio
- Comportamento do fluxo do rio



Perfil da analise na extremidade inferior do rio Licungo



(2) Modelação de Rio

Formação técnica sobre analise de modelação de rio

Data	2015/08/10 – 08/21	2015/08/27 – 09/10
Lugar	Maputo	Nampula
Participantes	15 pessoas: DNA, ARA-Sul, ARA-Zambeze, ARA-Centro, INAM, INGC/CENOE	22 Pessoas: ARA-Centro Norte, ARA-Norte, INGC, DPOPH, DPASA-NPL, FIPAC-NPL

Esta formação irá continuar em 2016

(3) Previsão de Cheia e Sistema de Previa Alerta

Modelo de precipitação-escoamento (IFAS => Auto IFAS)

+

Precipitação observada por satélite
[dados horários em toda a bacia com malha de 10 km]

↓

Previsão de cheia e sistema de previa alerta

Imagem de auto IFAS

Muito Obrigado

Appendix 1-5

Recommendation Report

Republic of Mozambique

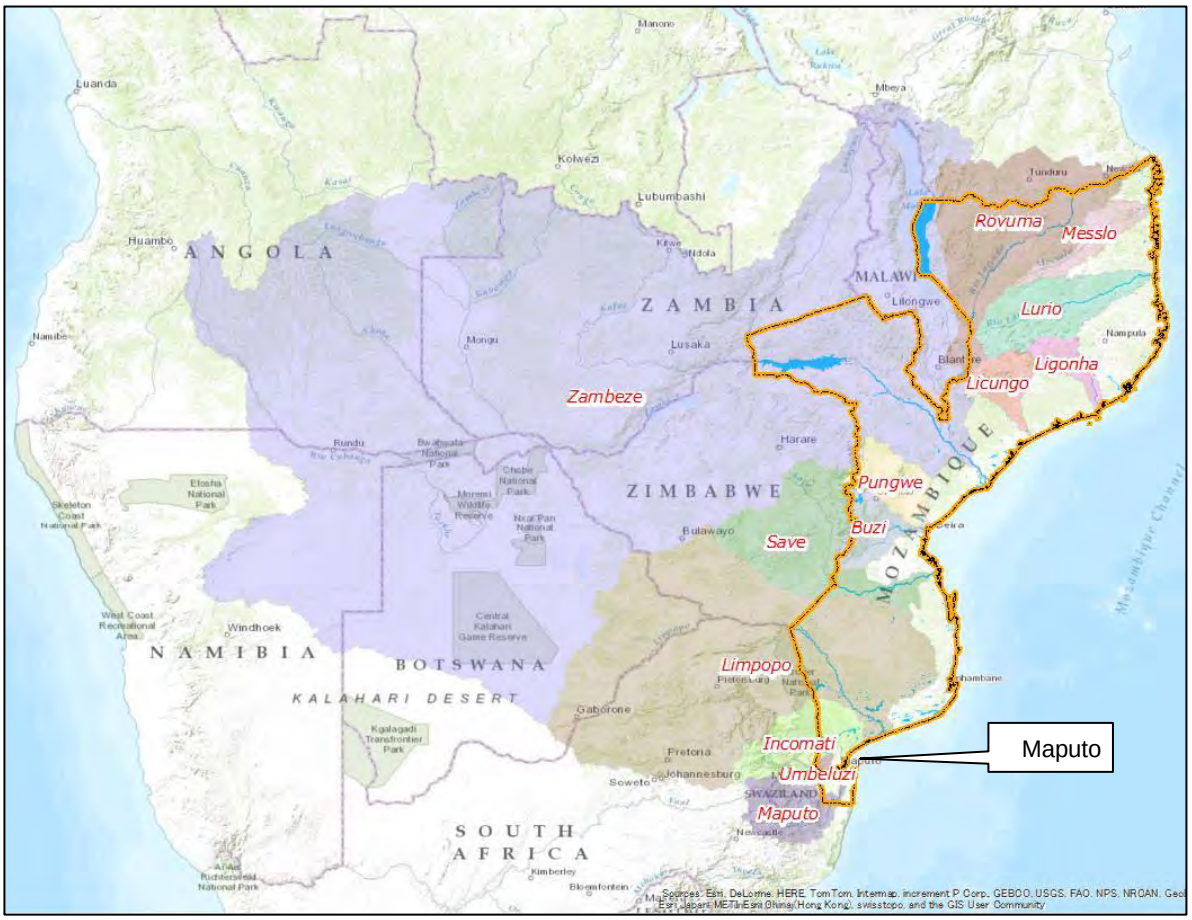
ASSISTANCE FOR ENHANCEMENT OF INSTITUTIONAL CAPACITY TO MANAGE WATER RELATED DISASTER RISKS IN MOZAMBIQUE

Recommendation Report on
Water Related Disaster Management,
Formulation of Water Related Disaster Management Plan, and
Human Resources and Institutional Development

December 2017

Japan International Cooperation Agency

IDEA Consultants. Inc



River Basin Area

River	Basin area in Mozambique	Total Basin Area	
Rovuma R.	101,160 km^2	155,400 km^2	(cross-border river)
Messalo R.	24,000 km^2	24,000 km^2	
Lurio R.	60,800 km^2	60,800 km^2	
Ligonha R.	16,299 km^2	16,299 km^2	
Licungo R.	27,726 km^2	27,726 km^2	
Zambeze R.	140,000 km^2	1,200,000 km^2	(cross-border river)
Pungwe R.	28,000 km^2	29,500 km^2	(cross-border river)
Buzi R.	25,600 km^2	28,800 km^2	(cross-border river)
Save R.	4,550 km^2	88,395 km^2	(cross-border river)
Limpopo R.	79,620 km^2	412,000 km^2	(cross-border river)
Incomati R.	14,925 km^2	46,246 km^2	(cross-border river)
Umbeluzi R.	2,356 km^2	5,600 km^2	(cross-border river)
Maputo R.	1,570 km^2	29,800 km^2	(cross-border river)

13 Major River Basins

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1 Introduction

1.1 Background of the Assistance

In recent years, development investment aiming toward economic growth is accelerated in Mozambique. On the other hand, natural disaster risk and the disaster damage have been increased because of climate change, development activities in domestic/neighboring countries, etc. Mozambique suffers from flood, cyclone, shore erosion, draught, etc. every year, and it is considered as the high-risk country for natural disaster caused by climate change according to UNISDR and World Bank. About 60% of the population lives in flood and cyclone prone areas such as coastal area and low-lying land. Flood and cyclone caused 1,267 deaths and 6.74 million victims in 2000 to 2013 (EM-DAT). The damage affected to social and economic areas. In the river basin of 9 cross-border rives of 13 major rivers, disaster risk is increased by development activities in not only Mozambique but also upstream countries.

The Mozambican government's policy and strategy regarding disaster management mainly focus on emergency response under the leadership of INGC but the implementing progress is limited. However, the national disaster management law was established in June 2014 after the long deliberation and the importance of the disaster management is increasingly recognized. Flood control is conducted by DNGRH and ARAs consisting of 5 regional offices, which are established in accordance with decentralization, but the main tasks of the both organizations are considered as water resource development, especially, effective water resource utilization, water environment management, etc. Because DNGRH and ARAs don't have the definite section in charge of disaster management, the review of the organization including organization reform is needed. In addition, human resources development with essential technical knowledge and skills is unsatisfactory. Mozambique requested the Japanese government "Project for Enhancement of Institutional Capacity of the National Directorate of Water Resources Management (DNGRH) and the Regional Water Administrations (ARAs) to Mitigate Natural Disaster Risk in Mozambique" with the above background and Japanese government adopted it. JICA and DNGRH discussed the component of it and confirmed the necessity of institutional strengthening to counter water related disaster. Finally both of them signed the minutes of discussion (MD) changing the project title to "Assistance for Enhancement of Institutional Capacity to Manage Water Related Disaster Risks in Mozambique"

1.2 Outline of the Assistance

Outline of the Assistance is summarized below.

Overall Goal

Institutional capacity of water related disaster risk management is enhanced in Mozambique.

Assistance Purpose

- DNGRH and other related organizations develop water related disaster management plan.
- DNGRH and ARAs enhance river basin management capacity.

Duration

From November 2014 to May 2018

Counter Part

- Implementing Agency: DNGRH、ARAs
- Related Agency: Ministry of Economy and Finance (MEF), National Institute of Disaster Management (INGC), National Institute of Meteorology (INAM), National Road Authority (ANE), National Directorate of Housing and Urbanization (DNHU), Directorate of Land Use Planning (DNAPOT), Ministry of Land, Environment and Rural Development (MTARD) and Ministry of Agriculture and Food Security (MINAG)

1.3 Work Flow

The Assistance was implemented for about 41 months from November 2014 to May 2018 as shown in the following work flow.

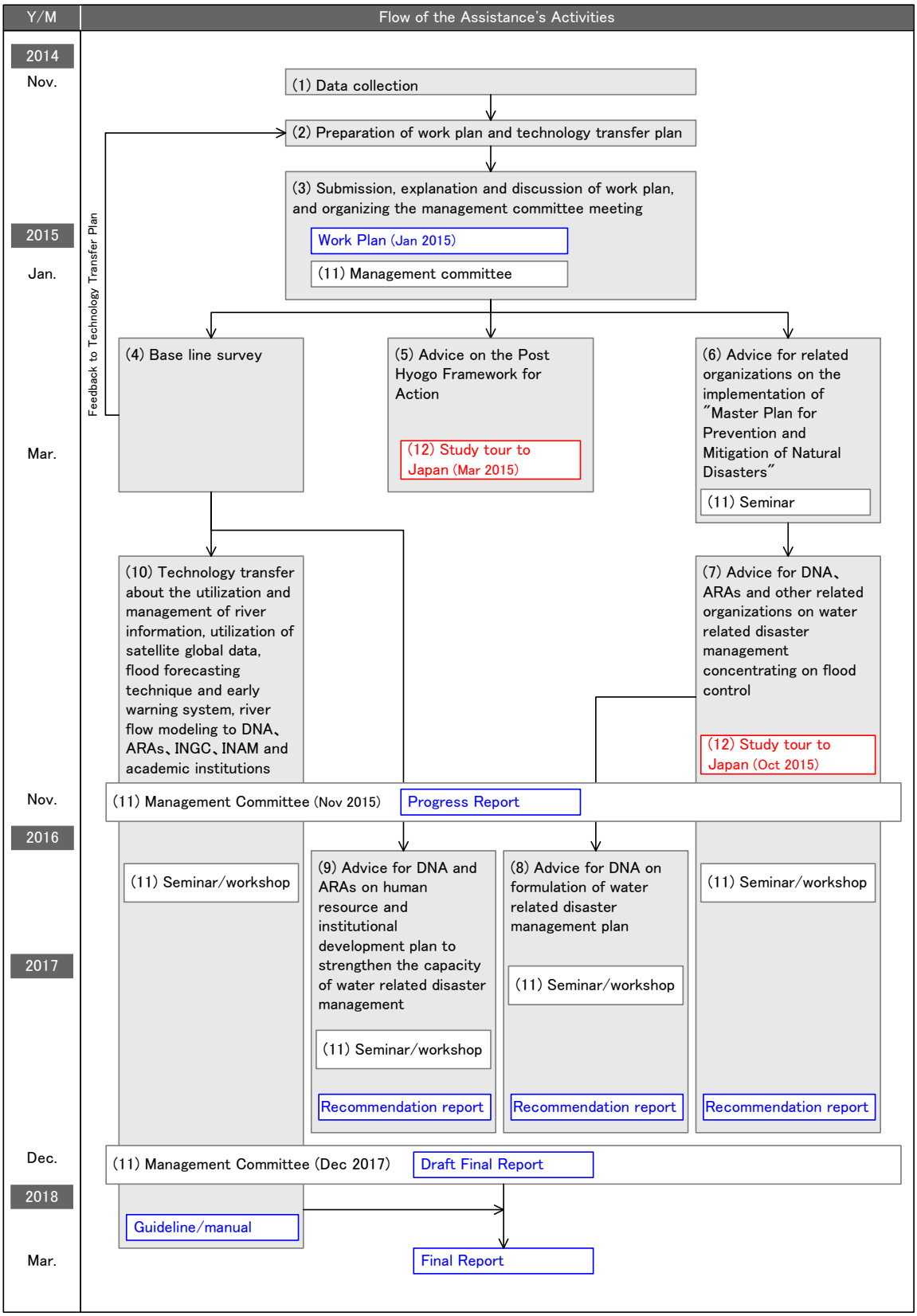


Figure 1.1 Work Flow

2 Recommendation on Water Related Disaster Management

In the Assistance, JICA Team advised C/Ps on water related disaster management through study tour to Japan, seminar, On-the-Job-Training, etc.

JICA Team conducted the above activities and made recommendation on water related disaster management in this report.

2.1 Water Related Disaster Management in Japan

(1) River Law

Change of River Law

1896 Birth of modern river management system focusing on flood control

Flood Control

1964 Establishing systematic management for flood control and water use

Flood Control + Water Use

1896 Development of comprehensive river management system for flood control, water use and environment

Flood Control + Water Use + Environment

(2) River Management Policy and River Improvement Plan

Each river has a long-term river management policy, and mid-term river improvement plan is established based on the policy.

Long-term river management policy

- Fundamental policy, return period of design flood, unregulated peak discharge, design flood discharge, etc.

Mid-term river improvement plan

- River management projects, details of river maintenance, etc.

(3) Roles of MLIT (Ministry of Land, Infrastructure, Transport and Tourism) in Disaster Management Cycle

Ministry of Land, Infrastructure, Transport and Tourism plays the following roles in disaster management cycle.

Disaster prevention:

- To improve and manage disaster management facilities
- To improve and manage disaster resilient facilities

Emergency response:

- To establish the system that enables immediate response to a disaster

・ To provide prefectural governments and municipalities necessary supports by TEC-FORCE system

Disaster Recovery:

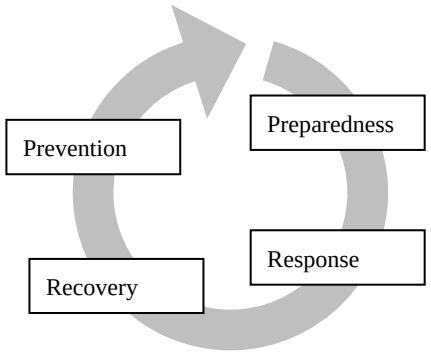
・ To raise funding and implement various projects

・ To manage disaster recovery system

Rehabilitation:

・ To raise funding and implement various projects

・ To provide assistance for construction of resilient towns against disaster



Disaster Risk Management Cycle

(4) River Classifications for Management

Class 1 Rivers (managed by MLIT):

・ River water systems deemed of particular importance to national land conservation and the national economy. Designated by MLIT Minister.

Class 2 Rivers (managed by Prefectural Governor or Mayor of Designated Cities):

・ Non-Class 1 River systems and water systems deemed important to the public interest. Designated by Prefectural Governor.

Secondary Rivers (managed by municipalities):

・ Non-Class 1 or Class 2 rivers, designated by the Mayor.

Standard Rivers (managed by municipalities):

・ Non-Class 1 or Class 2 or Secondary Rivers managed as public property.

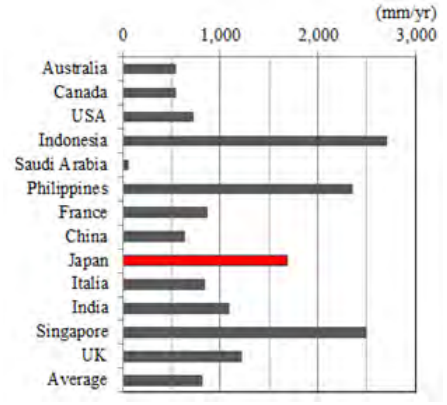
(5) Comprehensive Flood Control

Comprehensive flood control is applied for urbanizing river basin to deal with flood by not only river but also river basin. Comprehensive flood control consists of river improvement, measures in river basin and measures to alleviate damage as follows.

Comprehensive flood control measures	
River improvement	River channel improvement Dams, retarding basins, discharge channels, etc.
Measures in river basin	Urbanization control areas Conservation of fields Reservoirs Rainwater tanks Permeable pavements and seepage pits
Measures to alleviate damage	Evacuation warning system Flood-fighting, flood damage prevention activities Awareness of local residents

(6) Rainfall

Annual rainfall in Japan is approximately twice as much as the world average, 800 mm. Its volume per person of Japan is a third of the world average because of population and area. Volume of the precipitation of Japan is concentrated in Plum Rain and Typhoon season.



Annual Rainfall in the World

(7) Recent Flood Disaster

- Heavy rainfall on September 10, 2015 caused inundation disaster in Jyoso City.
- The Great East Japan Earthquake 2011 caused devastating tsunami disaster.
- Enormous sediment disasters occurred in Hiroshima City in August 2014. Debris flows occurred simultaneously from numerous streams and destroyed 255 houses.

(8) Economic Analysis of Flood Management Project

- There are some aspects to evaluate project feasibility, e.g. technical aspect, social and natural environmental aspect, economic aspect, financial aspect and institutional & managerial aspect. Economic analysis is one of the tools for project evaluation.
- Economic analysis;
  - brings a better allocation of resources,
  - examines the viability of the projects from the economic view point,
  - compares the benefit and the cost under with and without project conditions, and
  - provides information for decision making and selection of more appropriate measures.
- Indicators used for economic analysis
  - Internal Rate of Return (IRR): The IRR is a discount rate that makes the project's net present value of costs and benefits equal to zero.
  - Net Present Value (NPV): The NPV is difference between the present value of the benefits and the amount of investment expressed in discounted present values.
  - Benefit Cost Ratio (BCR): The BCR is the ratio of the benefits of a project relative to its costs expressed in discounted present values.

(9) Study Tour to Japan

Study Tour to Japan was conducted from 28 September to 8 October 2015 in order to learn river management and disaster management in Japan. Participants visited the following sites

in Japan.

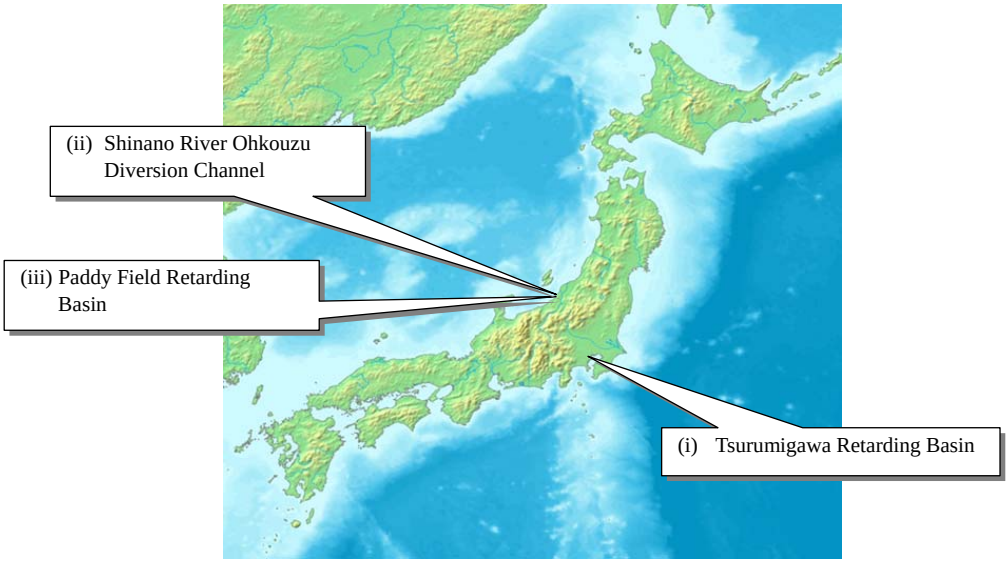


Figure 2.1 Location Map of Study Tour to Japan

(i) Tsurumigawa Retarding Basin

Tsurumi River has long been known as a raging river prone to repetitive flooding. In order to protect the surrounding communities as well as the communities further down the river from flood disaster, Tsurumigawa retarding basin takes flood water from the river during high water level and releases stored water after flood. During normal time, the retarding basin is open to the public as a park.

(i) Tsurumigawa Retarding Basin

Observation of the whole retarding basin

Watertight door on the building in retarding basin

Explanation on overflow levee

(ii) Shinano River Ohkouzu Diversion Channel

Construction of Ohkouzu Diversion Channel in Shinao River was commenced in 1909 and completed in 1922. It is man-made river and is 10 km in length. The function of the diversion channel is to control water flow and to divert flood water of Shinano River to the sea to protect the downstream area.

(ii) Shinano River Ohkouzu Diversion Channel

Mobable weir

Explanation of Ohkozu diversion using relief map

Observation port for fish-pass

(iii) Paddy Field Retarding Basin

Mitsuke City, Niigata Prefecture has promoted utilizing paddy field as emergency retarding basin during flood. An apparatus installed at the outlet of paddy field can control discharge and store water in paddy field at any height. The visit to paddy filed was introduced in local newspapers and city's web site.

(iii) Paddy Field Retarding Basin

「田んぼダム」視察

アフリカのモザンビーク政府関係者4人が2日、市内を訪れ、豪雨時に水田に一時的に水をためる「田んぼダム」などの水害対策を学んだ。

一行は市役所で、2004年の7・13水害以降の市の取り組みの説明を受け、住民への情報伝達方法や穴を開けた管で排水量を調整する田んぼダムの仕組みについて熱心に質問した。

その後、燕喜西町に移動して田んぼダムを視察した。カルロス・アンドレ・ジョベラ・ニャカさんは「材料費が安く効果的なので、すごく興味を持った」と話した。

視察は国際協力機構（JICA）のプロジェクトの一環で、9月29日に来日し、7日まで国内で研修する。県内では大河津分水も訪れた。

Niigata Nippo (2015/10/6)

Courtesy call on Mayor of Mitsuke City

(10) Recommendation

It is important to pursue on disaster reduction before disaster strikes in order to prevent/reduce damages caused by water disasters.

To deal with water related disasters, the followings need to be implemented in an integrated manner. The implementation will take long time, much budget and man power, and need hard coordination among various stakeholders. However, the organization in charge has to try to implement the countermeasures continuously and steadily.

- Cooperation among national and reginal governments, flood fighters, fire fighters and residents
- River improvement, construction of water reservoir, dam, dike, etc.
- Land use regulation and building codes

- Preparation of evacuation warning procedures, enhancement of disaster prevention trainings and education, and development of information dissemination mechanisms in disaster situations

2.2 Hydrological Observation

Hydrological data is fundamental information for water related disaster management, river basin management, water resources management, etc. Therefore, JICA Team made seminars regarding rainfall and inspected hydrological stations in Licungo River basin with C/Ps of Mocuba Unit.

(1) Observation System

(i) Rainfall observation

Staffs of Mocuba Unit and Gurue office observe hydrological data themselves at the stations in Mocuba and Gurue. On the other hand, at other stations people dwelling near the stations observe and record daily rainfall amount and water level once a day on consignment from Mocuba Unit.

Item	Description
Person in charge	Mr. Carlos Oreste Cugaguiua in Mocuba Unit Resident dwelling near a station
Observation frequency & time	Daily / 9:00
Frequency of collected data	Strategic stations: daily in strategic station Other stations: once 3 months at the moment (*) Strategic station: Mocuba and Gurue
Remuneration for observer (resident)	700 MT/month
Submit collected data to	ARA-CN
Frequency of submitting	Every day in rain season, every 2 day in non-rainy season by phone
Type of record (paper/electric file)	Electric file & paper
Problem	Budget, accuracy, maintenance

(ii) Water level observation

Staffs of Mocuba Unit and Gurue office observe hydrological data themselves at the stations in Mocuba and Gurue, respectively. On the other hand, at other stations people dwelling near the stations observe and record on consignment from Mocuba Unit.

Item	Description
Person in charge	Mr. Carlos Oreste Cugaguiua in Mocuba Unit Resident dwelling near a station
Observation frequency & time	1) 6:00, 12:00, 17:00 2) 6:00, 9:00, 12:00, 15:00, 17:00 (*) (*) During they predict high water level
Frequency of collected data	Strategic stations: daily in strategic station

Item	Description
	Other stations: once 3 months at the moment (*) Strategic station: Mocuba and Gurue
Remuneration for observer (resident)	700 MT/month
Submit collected data to	ARA-CN
Type of record (paper/electric file)	Electric file & paper
Problem	Budget, accuracy, maintenance

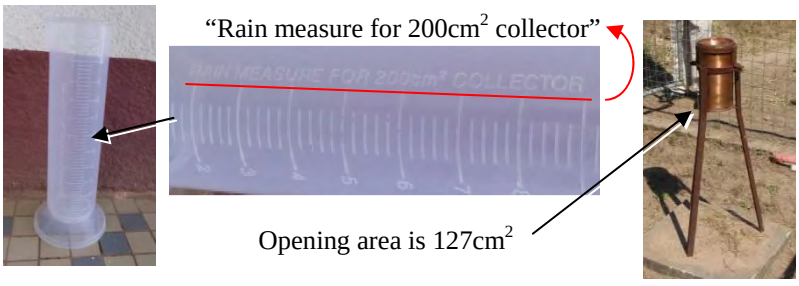
(iii) Discharge observation

Item	Description
Person in charge	Personnel of Mocuba-unit and Gurue office
Observation frequency	Daily / 9:00
Frequency of collected data	2 -3 times in a month They don't observe during flood due to high water level
Submit collected data to	ARA-CN
Frequency of submitting	When ARA-CN requests
Type of record (paper/electric file)	Electric file & paper
Problem	Maintenance of measurement equipment

(2) Problems of Hydrological Observation

- Mocuba Unit has difficulties in collecting the hydrological data recorded by local resident because of budget shortage for fuel for travel, reward to observer (MT 700/month).
- One rainfall station in Gurue is not surrounded by fence. Other rainfall stations are well maintained, e.g. adequate location, surrounding fence, weeding, etc. Some water level stations are left unrepaired after 2015 flood.
- Size of rainfall measuring glass used in Mocuba Unit is not adequate. The rainfall measuring glass is for a collector with 200 cm^2 of opening area but the collector actually has 127 cm^2 of opening area.

Rainfall station without fence



Size of measuring glass is not fit for rainfall gauge.

(3) Guidance by JICA Team

- Satellite-based rainfall, e.g. GSMaP, GFAS can provide rainfall distribution over a wide range. It is very helpful tools to obtain average rainfall over river basin especially for the

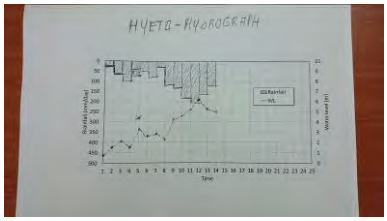
river basin with limited number of hydrological stations.

- GSMaP (Global Satellite Mapping of Precipitation): http://sharaku.eorc.jaxa.jp/GSMaP/index_zenkyu.html?date=NaNNaNNaNNaN&timecode=9
- GFAS: http://gfas.internationalfloodnetwork.org/n-gfas-web/PC/frmMain.aspx

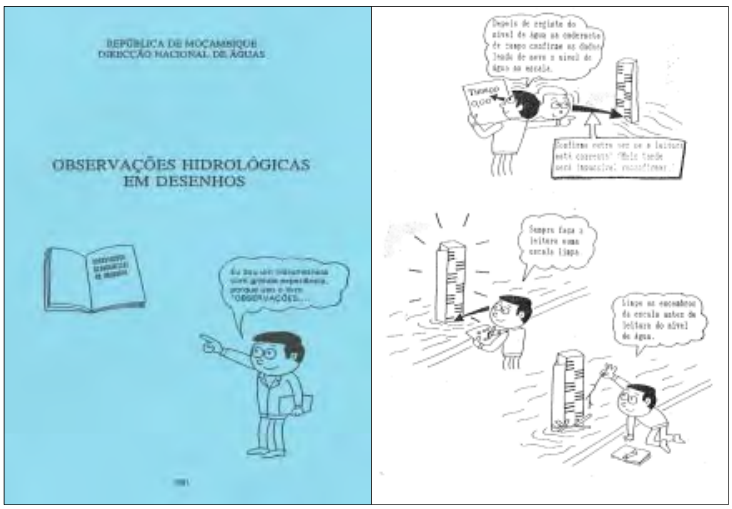
・ "Hydrological Observation Guidebook (Portuguese version)" which is utilized widely in Japan was introduced and its hard/soft copy was provided. The guidebook understandably explains hydrological observation with many illustrations.

・ Hyeto-hydrograph shows rainfall and water level (or discharge) in chronological order. The graph indicates time lag between peak rainfall and peak water level (or discharge), trend of fluctuation of water level, necessary time to evacuation, etc.

Satellite rainfall (GSMAP)



Exercise to draw hyeto-hydrograph



Hydrological Observation Guidebook

2.3 Inventory of River Management Structures

For water related disaster risk management, it is indispensable to grasp the current situation and problems of existing river management structures, e.g. dike, slope protection, weir, sluice gate, bridges crossing the river, etc. In order to sustain the functions of these river management structures, early detection and repair of the damages are also vitally important. Inventory of river management structures is helpful for these activities. Therefore, the inventory should describe structure's type, dimension, damage situation, influence by damage, urgency of repair, etc.

The purpose of the inventory of river management structures is neither preparing inventory sheets nor making base map. It is maintaining river management structures though early detection and repair utilizing the inventory. So, it is strongly recommended that C/Ps make efforts to prepare inventory sheets for all structures as soon as possible and start regular inspection in parallel.

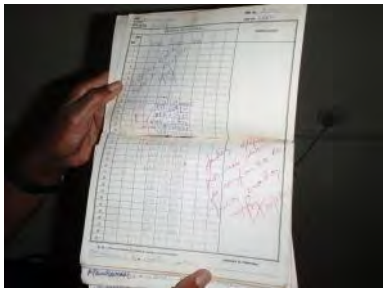
(1) Site Inspection

JICA Team and C/Ps visited some river management structures in order to discuss and clarify the present status, damage, problem on sites as follows.

Bridge: Insufficient span causes collision of flood wood and insufficient length of riverbank protection around a bridge abutment brings bank erosion. ARAs should give ANE appropriate advices for planning and designing a bridge from the viewpoint of river management.

Dike: Rehabilitation work of dike damaged by 2015 flood has been conducted. However, some sections remain open. Dike can produce an expected effect only if it connects continuously. Therefore, the rehabilitation work of dike should be completed without any opening.

Hydrological station: Hydrological station is mentioned in section 2.3.

 Erosion at hinter land of abutment	 Collapse of a bridge	 Bridge without guardrail
 Dike erosion by overtopping flow	 Bank protection (gabion mattress)	 Newly constructed dike
 Rainfall station without a fence	 Water level gauge	 Hydrological observation record

(2) Inventory of River Management Structures

Inventory of river management structures consists of inventory sheets and a base map.

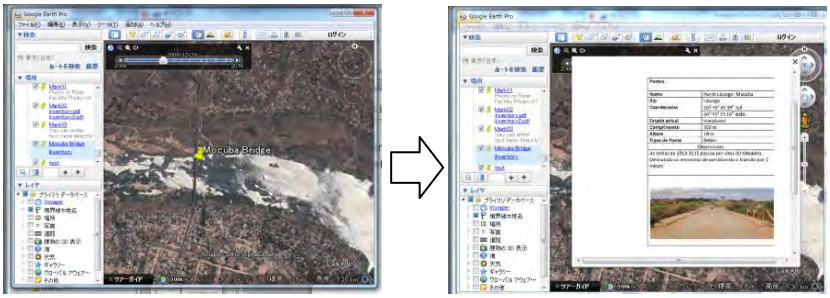
(i) Inventory sheet

- Objective structures for inventory sheet are rainfall station, water level station, dike, bridge, weir, etc.
- Inventory sheet is prepared as one file (PDF) for each river management structure.
- Contents to be described on an inventory sheet are name, ID number, jurisdictional office, river basin, river, location, coordinates, type of structure, start date of operation, status of operation, alert level, observer (name and contact number), damage history, etc. and the photo.

(ii) Base map

- Base map is prepared using Google Earth.
- Symbol or object expressing each structure is put on Google Earth. For example, dike is expressed as a line; a bridge is shown as an alphabet “B”; rainfall station is illustrated as a star symbol.
- Each symbol or object is linked to a corresponding inventory sheet. The inventory sheet appears by clicking the symbol or object.

Inventory sheet



Base map shows an inventory by clicking a symbol or an object.

2.4 Flood Response

The central and northern part of Mozambique, especially Licungo River basin suffered from severe flood disaster in the middle of January to the end of February 2015. More than 130 people were died and approximately 148,000 people were affected by the flood in Zambezia Province. In order to mitigate loss of life and damage to property, it is indispensable to distribute "easily understandable disaster information" based on a reliable flood forecast with appropriate lead time.

In May 2015, JICA Team conducted a workshop to review the 2015-flood in ARA-CN. In the workshop, the participants from various organizations stated that communities did not understand

the meaning of the flood forecast issued by DNGRH and ARAs.

In response to the above circumstances, JICA Team in collaboration with DNGRH and ARA-CN conducted field survey to grasp issues of the current routes, means, and messages of the disaster information from the central down to the community levels in the Licungo River Basin. Based on the analysis of the collected information and findings, JICA Team has presents the summary of recommendations for easily understandable disaster information as follows.

(1) Rationale

Issuance of disaster early warning and evacuation order is one of the effective non-structural measures to mitigate loss of life and property damages. Establishment of early warning system and role of relevant agencies are defined in "Disaster Management Law No.15/2014" and the guideline "Procedures and Rules of Information Flow of Disaster Early Warning" in Mozambique as discussed below:

(i) Disaster Management Law No.15/2014 (20 June 2014)

It is defined by Article 6 of the Disaster Management Law No.15/2014 (20 June 2014) that the Government regulates the monitoring of water catchment areas and effective early warning system that enables monitoring and prevention of hydro-meteorological phenomena that may cause disasters.

Article 15 of the Disaster Management Law defines early warning system as follows:

a. Early warning system is coordinated centrally by the coordinating institution of disaster management and integrates the different institutions responsible for forecasting and monitoring of phenomena likely to cause disasters.
b. Early warning can be local or national levels depending on the areas with risk of occurrence of disasters.
c. The Government defines responsibility for issuing early warning for disasters.

About compulsory evacuation of the people and properties in high risk areas, Article 39 of the Disaster Management Law defines as follows:

a. The Council of Ministers determines the compulsory evacuation, temporary or permanent, of persons and property situated in high-risk areas.
b. In a situation of imminent danger, the temporary compulsory evacuation of people and goods can be determined by the provincial governor, district director or chairman of the relevant city council because the territory.

(ii) Guideline on Information Flow of Disaster Early Warning

Authorities in charge of the risk assessment and the disaster management should be clearly differentiated. This demarcation of roles of organizations is defined in the guideline "Procedures and Rules of Information Flow of Disaster Early Warning in Mozambique" prepared by INGC. The guideline says that DNGRH, INAM, DNG and MOA have competencies for issuing warning on flood, drought, cyclone, weather, tsunami, earthquake, and agrometeorological drought from the technical viewpoint. INGC issues additional specific warning about impact, measures, preparedness and response including evacuation order based on the technical disaster warning issued by the relevant agencies. Figure 2.2 shows image of authorities of issuances of flood warning and evacuation order.

INGC	Additional specific warning about impact, measures and action for preparedness & response

Competencies for Issuing Warning	
DNA	Flood and drought along the river basin
INAM	Cyclone, weather and tsunami
DNG	Earthquake
MOA	Agrometeorological drought

Demarcation of Roles in Issuance of Warning

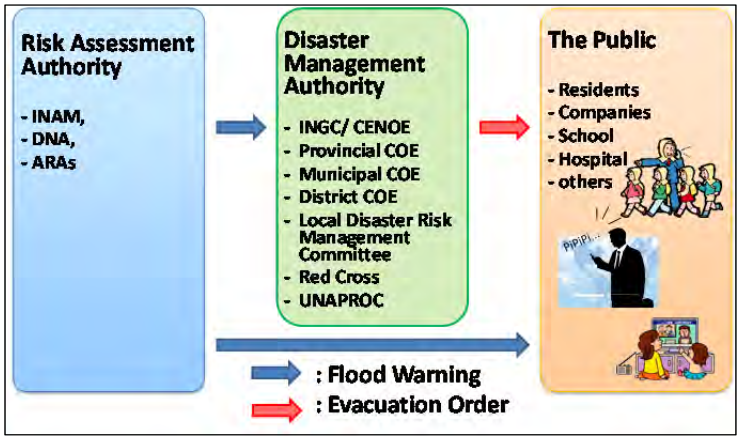


Figure 2.2 Authorities of Issuances of Flood Warning and Evacuation Order

(2) Flood Response by Mocuba Unit

Mocuba Unit has issued a flood warning based on observed water level so far. It may not give community people enough time to evacuate or to protect their property before flood reaches. In order to early evacuate and surly mitigate damage, DNGRH will commence operating a new flood early warning system using Auto-IFAS (Integrated Flood Alert System) for Licungo River basin in rainy season 2017-2018. Auto-IFAS can predict future water level using actual rainfall (satellite-based rainfall). Therefore, Mocuba Unit can issue a flood warning based on predicted water level. JICA Team and C/Ps examined flood response corresponding to the new flood early warning system so that community people can

understand a received flood warning without fail and evacuate to safe place in advance.

(i) Flood warning dissemination route

Mcouba Unit has issued a flood warning so far when observed water level reaches a designated alert level. The existing dissemination route for the flood warning is shown below. For the new flood warning system, this dissemination route will be also utilized.

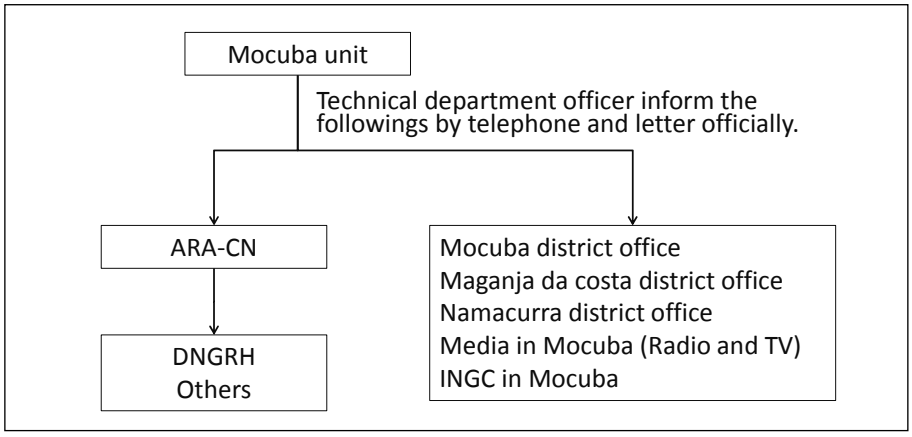
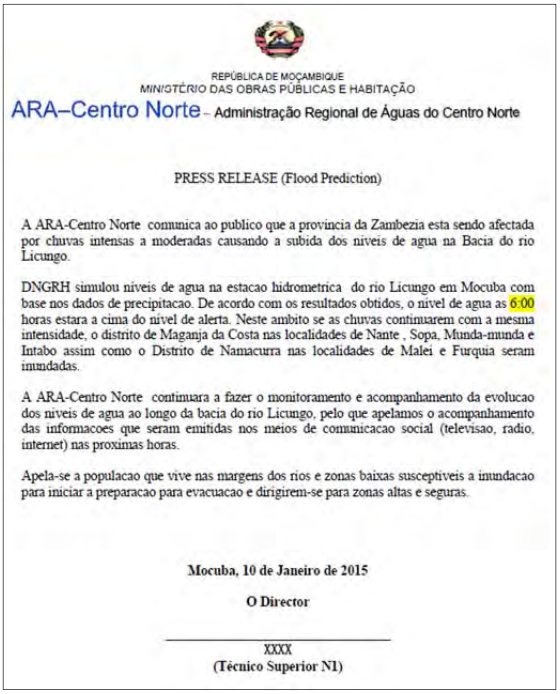


Figure 2.3 Dissemination Route of Flood Early Warning

(ii) Flood response plan

JICA Team and C/Ps examined flood response corresponding to the new flood warning system and explained it to the organizations which receive a flood warning from Mocuba Unit. And they finally established flood response flow as a plan.

- Mcouba Unit observes water level at Mocuba Bridge three times per day (at 6:00, 12:00 and 17:00) during normal time and 5 times per day (at 6:00, 9:00, 12:00, 15:00 and 17:00) during flood. Mocuba Unit informs the observed value to DNGRH which operates Auto-IFAS.
- Two kinds of warning message were prepared. One accelerates people to prepare evacuation and the other urges them to evacuate. The former is issued four to six hours before predicted time that water level reaches the alert level and the latter is issued one to three hours before that. Both of them clearly mention that the warning is issued based on predicted water level.



REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DAS OBRAS PÚBLICAS E HABITAÇÃO
ARA–Centro Norte – Administração Regional de Águas do Centro Norte

PRESS RELEASE (Flood Prediction)

A ARA-Centro Norte comunica ao publico que a provincia da Zambezia esta sendo afectada por chuvas intensas a moderadas causando a subida dos niveis de agua na Bacia do rio Licungo.

DNGRH simulou niveis de agua na estacao hidrometrica do rio Licungo em Mocuba com base nos dados de precipitacao. De acordo com os resultados obtidos, o nivel de agua as 6:00 horas estara a cima do nivel de alerta. Neste ambito se as chuvas continuarem com a mesma intensidade, o distrito de Maganja da Costa nas localidades de Nante , Sopa, Munda-munda e Intabo assim como o Distrito de Namacurra nas localidades de Malei e Furquia seram inundadas.

A ARA-Centro Norte continuara a fazer o monitoramento e acompanhamento da evolucao dos niveis de agua ao longo da bacia do rio Licungo, pelo que apelamos o acompanhamento das informacoes que seram emitidas nos meios de comunicacao social (televisao, radio, internet) nas proximas horas.

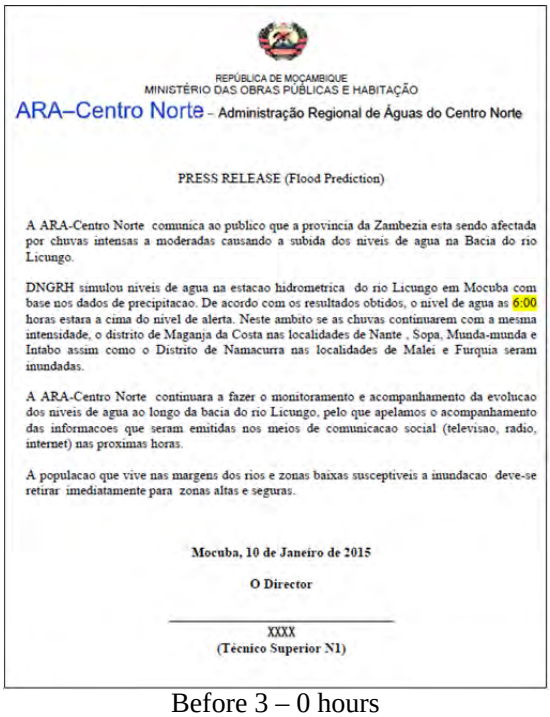
Apela-se a populacao que vive nas margens dos rios e zonas baixas susceptiveis a inundacao para iniciar a preparacao para evacuacao e dirigirem-se para zonas altas e seguras.

Mocuba, 10 de Janeiro de 2015

O Director

XXXX
(Técnico Superior N1)

Before 6 – 4 hours



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A populacao que vive nas margens dos rios e zonas baixas susceptiveis a inundacao deve-se retirar imediatamente para zonas altas e seguras.

Mocuba, 10 de Janeiro de 2015

O Director

XXXX
(Técnico Superior N1)

Before 3 – 0 hours

Flood Warning Message

- C/Ps of Mocuba Unit and JICA Team visited relevant organization, which are Mocuba radio station, INGC in Mocuba, Mocuba district office, Maganja da Costa district office, Namacurra district office to explain the new early warning system. C/Ps prepared a briefing material for the explanation as shown below and translated into Portuguese.

Flood Early Warning System & Flood Prediction Information

August 2017

Mocuba unit of ARA-CN

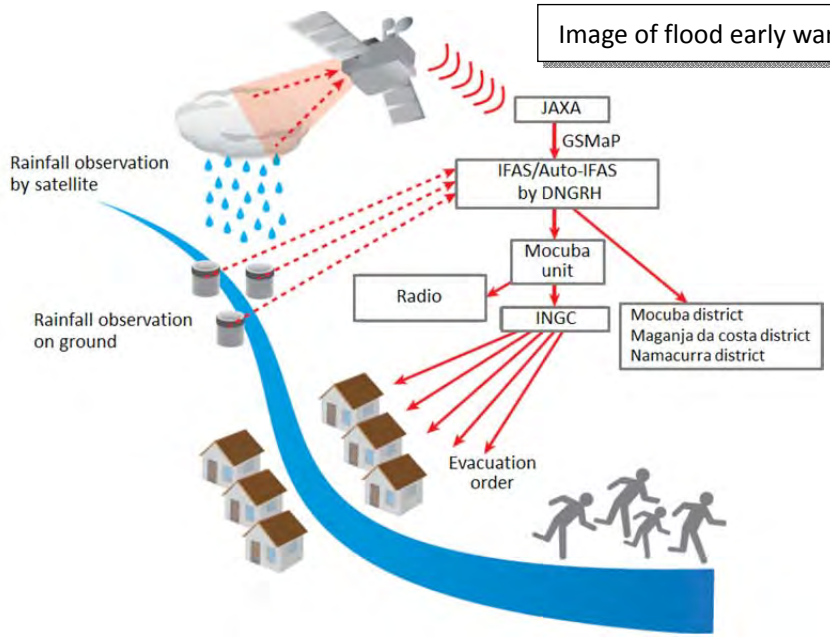
1. General

DNGRH will launch Flood early warning system in next rainy season. Mocuba unit will issue flood prediction information in addition to existing flood warning.

2. Flood Early Warning System

Flood early warning system simulates future water level using rainfall observed by satellite and enables earlier response and evacuation in order to reduce flood damage. DNGRH simulates future water level using rainfall observed satellite. Based on the simulation result, Mocuba unit provides flood prediction information for media, INGC, districts before flood warning based on observed water level.

Image of flood early warning system



3. Flood Prediction Information

Mocuba unit issues “Flood Prediction Information” to you.

This information includes predicted water level and the time, and preparation/execution of evacuation as follows.

Example 1: DNGRH simulou niveis de agua na estacao hidrometrica do rio Licungo em Mocuba com base nos dados de precipitacao. De acordo com os resultados obtidos, o nivel de agua as 6:00 horas estara a cima do nivel de alerta. Apela-se a populacao que vive nas margens dos rios e zonas baixas susceptiveis a inundacao para iniciar a preparacao para evacuacao e dirigirem-se para zonas altas e seguras.

Example 2: DNGRH simulou niveis de agua na estacao hidrometrica do rio Licungo em Mocuba com base nos dados de precipitacao. De acordo com os resultados obtidos, o nivel de agua as 6:00 horas estara a cima do nivel de alerta. A populacao que vive nas margens dos rios e zonas baixas susceptiveis a inundacao deve-se retirar imediatamente para zonas altas e seguras.

- C/Ps finally prepared a flow chart for flood response as a flood response plan as shown bellow.

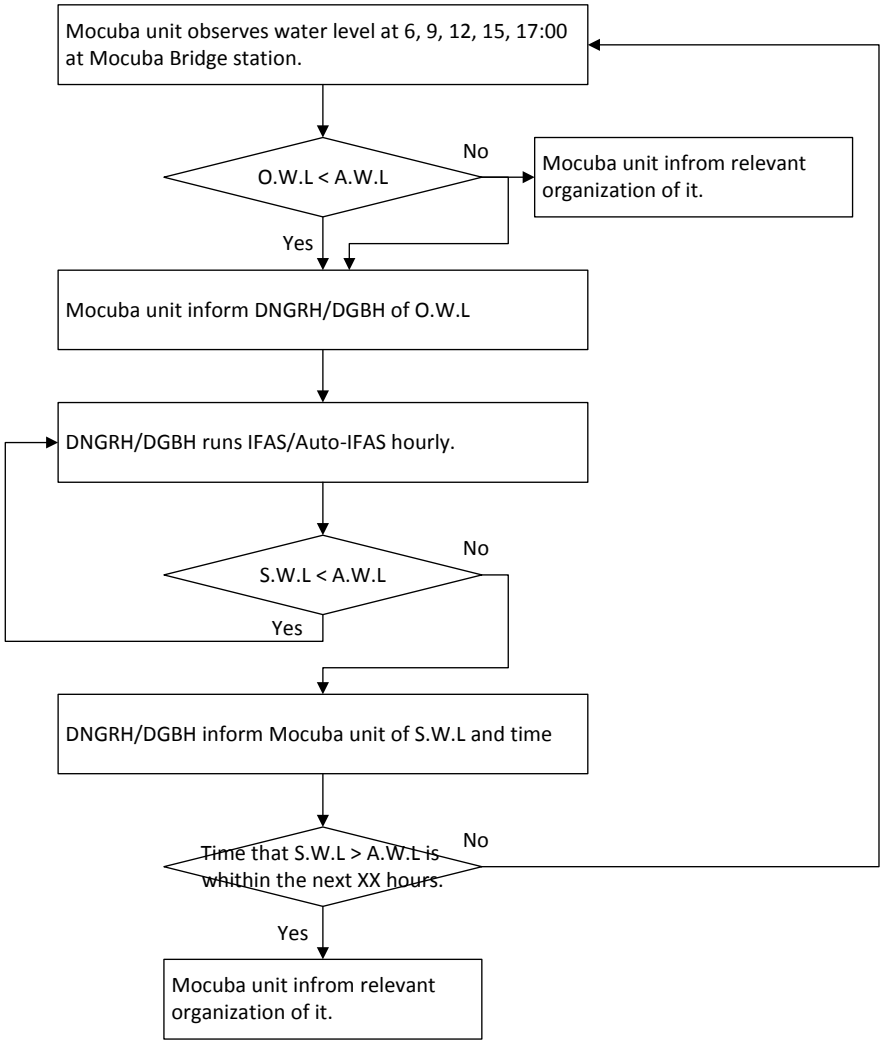


Figure 2.4 Flood Response Flow

(3) Distribution of Easily Understandable Disaster Information

In order to mitigate flood damage surly, people receiving the warning message must understand the urgency and take the correct action. Disaster information flow and contents are shown and easily understandable disaster information of each organization is described below.

(i) Flow and Contents of Disaster Information

Flow of disaster information dissemination is illustrated in Figure 2.5. And means and kind of the information of each organization are summarized in Table 2.1.

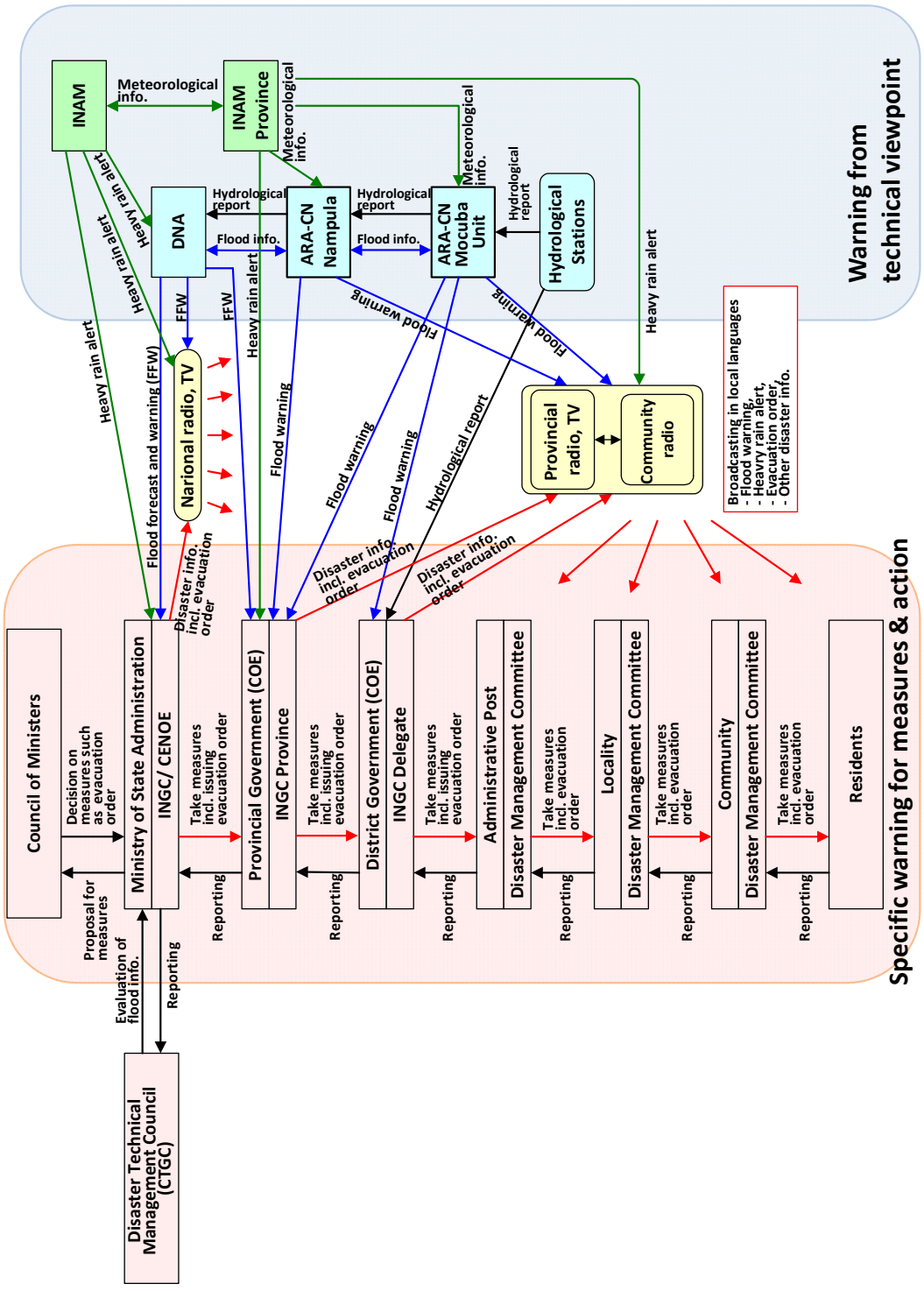


Figure 2.5 Flow and Kind of Disaster Information

Table 2.1 Flow, Means and Kind of Disaster Information

Organization Name	Receiving Disaster Information			Disseminating Disaster Information			Remarks
	From	Means	What Information	To	Means	What Information	
ARA-CN Mocuba	Observers in Gurue, Lugela, Mocuba, Maganja da Costa	Cell-phone, SMS	- Hydrological report	- Radios (province, community, private), - Provincial Gov. - District Gov., - Basin Committee members, - INGC Prov. & Dist. - DNGRH - ARA-CN - The Red Cross	- Email, - Cell-phone - Radio-communication	- Flood warning (in case of emergency)	- Root and the fastest information - Evacuation order by local government (with INGC) is issued based on this flood warning. (In Portuguese)
	INAM	Email, TV, radio	- Meteorological report				
	ARA-CN	Email, Cell-phone, SMS, radio-communication	- Flood warning				
	DNGRH	Email, Cell-phone, SMS, radio-communication	- Flood forecast				
ARA-CN HQ Nampula	Units of ARA-CN	Email, Cell-phone, SMS, radio-communication	- Hydrological report	- Provincial Gov. (Nampula, Zambezia) - DNGRH - DPOPH (Nampula, Zambezia) - INGC (Nampula, Zambezia), - FIPAG-Nampula, - INAM (Nampula, Zambezia) - ANE Nampula, - RM Nampula, - FIPAG Nacala, - Wampula Fax - Nampula, - Notícias-Nampula, - TVM-Nampula, - Kenmare Morna Mining, - Matanuska Mozambique, - Dir. Prov. Agricultura de	- Email - Cell-phone	- Regional hydrological bulletin - Flood warning (in case of emergency)	(In Portuguese)
	DNGRH	Email, Cell-phone,	- Hydrological bulletin				
	INAM	Email, Fax	- Meteorological bulletin				

Organization Name	Receiving Disaster Information			Disseminating Disaster Information			Remarks
	From	Means	What Information	To	Means	What Information	
				Nampula - River basin committee			
DNGRH	ARAs	Email, Cell-phone, SMS, radio-communication	- Regional hydrological bulletin, - Flood warning (in case of emergency)	- MOPHRH, - GABINFO, - TVM, - RM, - DPOPH, - Jornal Notícias, - CENOE/INGC, - Jornal Diário de Moçambique, - MINAG-DNSA, - Soico/Televisão, - Nutrição/MINAG, - ARAs	- Email - Fax	- National hydrological bulletin (regularly) - Flood warning (in case of emergency)	(In Portuguese)
	Units of ARAs	Email, Cell-phone, SMS, radio-communication	- Hydrological report - Flood warning (in case of emergency)				
	INAM	Email, Fax	- Meteorological bulletin - Weather warning				
INGC/ CENOE	DNGRH	CTGC Email	- National hydrological bulletin - Flood warning (in case of emergency)	- Provincial COE - TVM - RM - Newspaper - CTGC	- Fax - Phone - Email - Radio-communication	- Flood warning (in case of emergency)	(In Portuguese)
	INAM	CTGC Email	- Meteorological bulletin - Weather warning				
	Other concerned agencies	CTGC Email	- Situation report				
Provincial COE/ INGC	ARA-CN	Email Cell-phone	- Regional hydrological bulletin - Flood warning (in case of emergency)	- District COE/ INGC district - Provincial Radio, TV - Community Radio	- COE meeting - Fax - Email - Cell-phone - Radio-communication	- Flood warning	(In Portuguese)
	INAM province	Email, Cell-phone	- Meteorological bulletin - Weather warning				
	INGC/ CENOE	Fax, Phone, Email, Radio-communication	- Flood warning (in case of emergency)				
	ARA-CN Mocuba Unit	Email, Cell-phone	- Flood warning (bulletin)				
District COE/ INGC	ARA-CN Mocuba Unit	Email, Cell-phone	- Flood warning (bulletin)	- Administrative post chief	- COE meeting - Cell-phone	- Flood warning and evacuation order	(In Portuguese)

Organization Name	Receiving Disaster Information			Disseminating Disaster Information			Remarks
	From	Means	What Information	To	Means	What Information	
			- Regional hydrological bulletin	- Locality chief - Community leader - Provincial radio - Community radio - Provincial COE/ INGC	- Email - Fax - Poster for community people		
	Provincial COE/ INGC	Email, Cell-phone Radio-communication	- Flood warning (bulletin) - Hydrological bulletin of DNGRH				
	Observer in District	Cell-phone	- Water level information				
	Administrative post chief	Cell-phone, District COE meeting	- Situation report				
	Locality chief	Cell-phone, District COE meeting	- Situation report				
	Community DMC coordinator	Cell-phone, District COE meeting	- Situation report				
	INAM	TV, Radio	- Weather information				
Administrative Post	District COE/ Province INGC	Cell-phone, District COE meeting	- Flood warning	- Locality chief, - Regulo, - Community leader, - Church, Mosque - Local committee for disaster risk management (CLGRC)	- Cell-phone - DMC meeting	- Flood warning and evacuation order	(In local language)
	ARA-CN	Cell-phone	- Flood warning (bulleting)				
	TV	Broadcasting	- News on flood warning				
	RM (National/ Provincial)	Broadcasting	- News on flood warning				
Locality	Administrative Post DMC	Cell-phone, Administrative Post DMC meeting	- Flood warning	- Community leaders - Local committee for disaster risk management (CLGRC)	- Cell-phone - DMC meeting	- Flood warning and evacuation order	(In local language)
	TV	Broadcasting	- News on flood warning				
	RM (Provincial/ National)	Broadcasting	- News on flood warning				
	Community Radio	Broadcasting	- News on flood warning				
Community DMC	Locality DMC	DMC meeting (Cell-phone)	- Flood warning	- Residents	- Portable loudspeakers - Drums	- Flood warning and evacuation order	(In local languages)
	RM (Provincial/)	Broadcasting	- News on flood warning				

Organization Name	Receiving Disaster Information			Disseminating Disaster Information			Remarks
	From	Means	What Information	To	Means	What Information	
	Community Radio	Broadcasting	- News on flood warning		- Whistles - Flags		
Radio Mozambique (Provincial radio)	INAM Provincial	- Email, - Fax	- Weather information	- Public	- Broadcasting	- Flood warning and evacuation order	(In Portuguese and 3 local languages) - Cover all Zambezia Province by AM radio broadcast
	ARA-CN HQ	- Email, - Fax	- Flood warning (bulletin)				
	ARA-CN Mocuba	- Email	- Flood warning (bulletin)				
	Provincial COE/ INGC	- Email, - Fax - COE meeting	- Flood warning and evacuation order (bulletin)				
	District COE/ INGC	- Email, -Fax	- Flood warning and evacuation order (bulletin)				
	RM (Reporter at site)	- Internet	- Situation of the sites				
Community Radio	INAM Provincial	- Email, - Fax	- Weather information	- Public	- Broadcasting	- Flood warning and evacuation order	(In Portuguese and local languages) - Covers a circle with radius of 50km or less
	ARA-CN HQ	- Email, - Fax	- Flood warning (bulletin)				
	ARA-CN Mocuba	- Email	- Flood warning (bulletin)				
	Provincial COE/ INGC	- Email, - Fax	- Flood warning and evacuation order (bulletin)				
	District COE/ INGC	- Email, -Fax - COE meeting	- Flood warning and evacuation order (bulletin)				
	RM (Reporter at site)	- Internet	- Situation of the sites				

(ii) Easily understandable disaster information

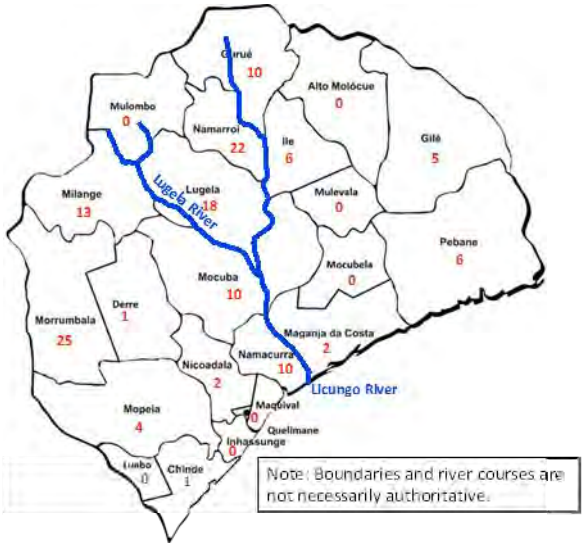
C/Ps and JICA Team reviewed disaster information issued by each organization and prepared recommendation to make it more easily understandable for receiver. The recommendation on disaster information issued by each organization is as follows.

a) ARA-CN Mocuba Unit

ARA-CN Mocuba Unit plays the most important role in issuing flood early warning in the Licungo River basin. Mocuba Unit is responsible for management of the Licungo River Basin and it receives hydrological reports from the observers in the upstream, midstream and downstream. Therefore, it knows the likelihood of flooding in the first place. In case of flooding is anticipated, ARA-CN Mocuba Unit issues flood warning to Provincial Gov., District Gov. Provincial and Community Radios, and other predetermined recipients. The evacuation orders by District COEs are issued based on the ARA-CN Mocuba Unit's flood warning.

Observation of water level had been performed three times a day at 6:00, 12:00 and 18:00 in normal time and another two times at 9:00 and 15:00 when water level have exceeded the alert level. Absence of the observation for 12 hours in night time had been a serious problem for issuing flood early warning. However, hydrological observation in night time will be started at Gurue, Lugela, Mocuba and Nante in case flooding is anticipated. This effective approach has become possible because employment status of the observers have been changed.

According to the Review Report on the Contingency Plan for Flood and Cyclone Season 2014/2015, there are considerable number of flood victims in the middle to upstream reaches of the Licungo River such as Gurue, Lugela, Namarroi, Ile districts (total deaths: 56 persons in 4 districts). It is necessary to clarify the cause of deaths but if they are due to flash flood and/or debris flow, early warning for those areas should be enhanced.



Death Toll by the 2015-Flood in Zambezia Prov.

An example of flood warning issued by ARA-CN Mocuba Unit is

presented in Figure 2.6. DNGRH, ARAs and their Units use almost same format. It has issuer's letter head, release number, narrative description of the current situation of rainfall and water level comparing with alert level. Based on the rainfall forecast for next 48 hours, recommendations are given such as “keep away from the riverine areas”, “don't across the river”, “keep properties away from risk areas”, and “keep on monitoring information of ARA, DNGRH and other authorities”.

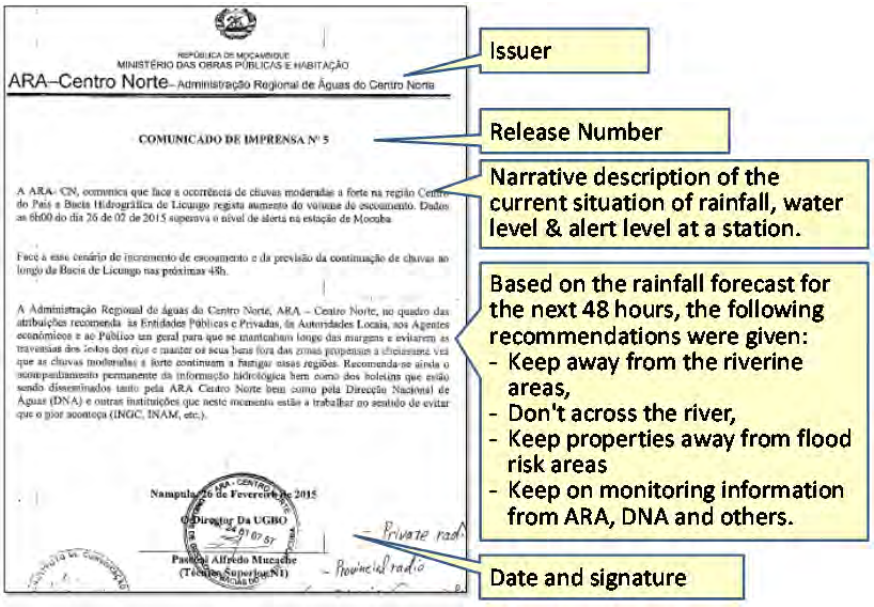


Figure 2.6 Example of flood warning issued by ARA-CN Mocuba Unit

Recommendations

The flood warning of ARA-CN Mocuba Unit includes necessary message and is easy to understand but it can be enhanced by including these messages. For example, ARA-CN Mocuba Unit does not have authority to issue evacuation order, but it should recommend local authorities to issue evacuation order for the risk area from the technical viewpoint.

Example 1
ARA - Centro Norte recommends AAA and BBB Districts to issue evacuation order for the people reside in the riverine flood risk areas.

Even though the forecasted flood is very strong, if it is not explained, the people think it will be normal flood that occurs every year. Therefore, if the forecasted phenomenon is very severe, these kinds of easily understandable expression should be used comparing with the past severe events.

Example 2

- "the massive flood we have never experienced recent years"
- "the severe flood that is comparable to the Flood 2015"
- "the heavy rainfall we have never experienced recent years"
- "the strong cyclone that is stronger than the cyclone Funso in 2012"

Also if the release has a short title such as "Flood Warning for the Licungo River Basin" or "Flood Warning for the riverine areas of Maganja da Costa and Namacurra Districts", the recipient can easily find the importance of the document.

Example 3

Short Title of the Document (Release)

- " Flood Warning for the Downstream Areas of the Licungo River Basin"
- " Flood Warning for the riverine areas of Maganja da Costa and Namacurra Districts"

Since almost all the flood information relies on the observation data of ARAs' Units. Reliable information should be issued by ARAs' Units to establish credibility of the recipients (cross-check figures and units).

b) ARA-CN HQ in Nampla

ARA-CN Nampla receives flood information from its Units, DNGRH and INAM. ARA-CN also use satellite imaginary of SADC to analyze flooding. In case flooding is predicted, ARA-CN issues flood warning to Provincial Gov., INGC, ANE, Provincial and Community Radios, and other predetermined recipients as shown in Table 2.1 and illustrated in Figure 2.5. Basically composition of the flood warning of ARA-CN is the same as that of ARA-CN Mocuba Unit.

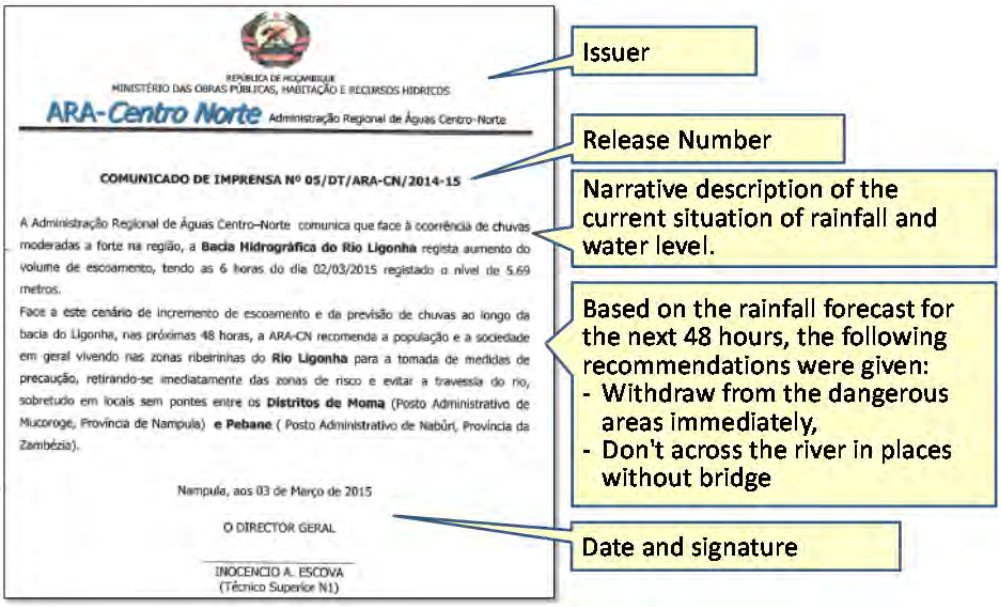


Figure 2.7 Example of flood warning issued by ARA-CN Nampula

Recommendations

The flood warning of ARA-CN also includes necessary message and easy to understand, but it can be enhanced by including these messages. For example, ARA-CN should recommend Provincial COE to issue evacuation order for the risk area from the technical viewpoint.

Example 4
ARA - Centro Norte recommends AAA Provincial COE to issue evacuation order for the people reside in the flood risk areas of the Licungo River Basin.

Also, if the phenomenon is very severe, the easily understandable expression should be used comparing with the past severe disasters as presented in Example 2. These kinds of expression have been used in Japan in order to make people understand the severity of the hazard. Also a short tile will help the recipients to see what kind of release immediately as presented in Example 3.

c) DNGRH

DNGRH receives flood information from ARAs, INAM, sometimes directly from the Units of ARAs. DNGRH disseminates flood warning based on the received information and on the result of flood simulation analysis to ARAs, INCG, media and other relevant agencies as presented in Table 2.1 and illustrated in Figure 2.5.

Figure 2.8 shows an example of press release of flood warning issued by DNGRH. Composition of the warning is almost same as those of ARAs and Units. Based on the current situation, DNGRH recommends to withdraw from the riverine areas and to follow the instruction of authorities.

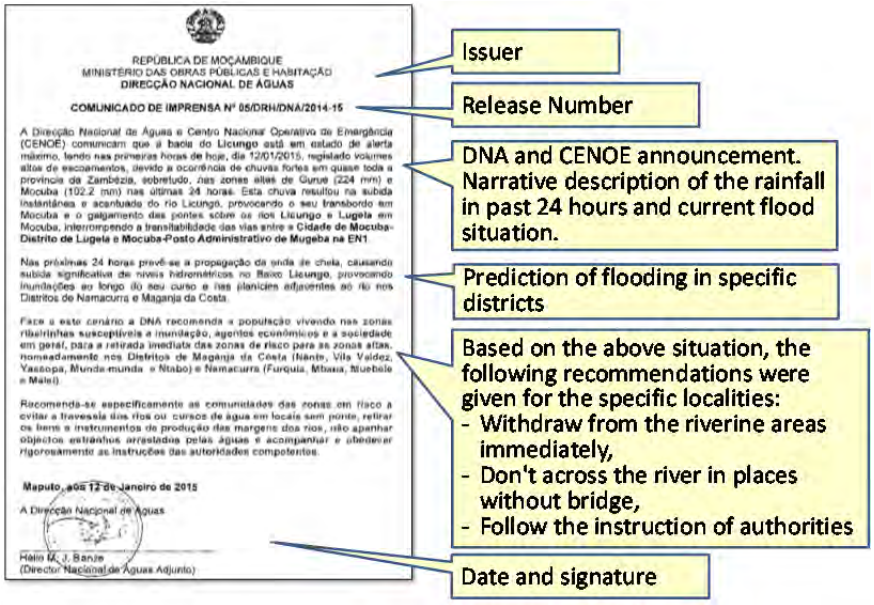


Figure 2.8 Example of flood warning issued by DNGRH

Recommendations

It is recommended that DNGRH recommends CENOE to issue evacuation order for the specific risk areas as shown below:

Example 5

DNGRH recommends CENOE to issue evacuation order for the people reside in the flood risk areas of the Licungo River Basin.

Also if there is the threat of severe flood disaster, DNGRH should recommend CENOE to deploy the National Civil Protection Unit (UNAPROC) for disaster relief mission. Also international call should be recommended from the technical view point.

Example 6

- DNGRH recommends CENOE to deploy the National Civil Protection Unit (UNAPROC) for disaster relief mission in AAA and BBB Districts.
- DNGRH recommends CENOE to call support for donor community.

Also the title of the release (Example 3) and expression of severity (Example 2) should be used for easily understandable disaster information.

d) INGC/ CENOE

INGC/ CENOE receive flood warning and/or weather warning from DNGRH and INAM. Then the flood warning is evaluated by CTGC. The measures to cope with the hazard are proposed by CENOE and the measures including evacuation order is determined by the Council of Ministers.

The evacuation order is implemented through administrative line from Central, Province, District, Administrative Post, down to Locality. At the same time evacuation order is broadcasted through TV, National, Provincial and community radios, and other medias like newspapers.

e) Provincial COE/ INGC

Same like INGC/ CENOE, the Provincial COE/ INGC receive flood warning from ARAs, the Units and INAM in provincial level. If the disaster is imminent, evacuation order is issued by decision of Provincial Governor without waiting for decision of the Council of Ministers. The Evacuation order is disseminated to the people through District COE/ INGC and Provincial and community radios as shown in Table 2.1 and illustrated in Figure 2.5.

INGC has delegates in district level and they report hydrological and meteorological information at Gurue, Lugela, Mocuba, Namacurra and Maganja da Costa everyday by the radio communication in the Licungo River Basin. If water levels exceed the alert levels, they convey the information to the delegates in downstream and also to INGC Provincial delegation. In case of emergency, INGC Zambezia Province elaborates flood warning including evacuation order (bulletin) based on the delegates' report, ARA and INAM's bulletin, etc. INGC's flood warning and evacuation order are sent to local government and all the related agencies including Provincial and community radios for dissemination.

<u>Recommendations</u>

Provincial COE/ INGC's flood warning and evacuation order should also use expression of severity (Example 2) based on the flood warning of DNGRH and ARAs, if the imminent hazard is very severe.

f) District COE/ INGC

District COE/ INGC receive weather information from INAM, flood warning from ARA's Unit and water level information from observers in the District. District COE/ INGC receive evacuation order from Provincial COE/ INGC.

District COE/ INGC elaborates evacuation order based on the received flood warning from ARA-CN or its Unit and issues the evacuation order by Administrator. The evacuation order is disseminated through Administrative Posts, Localities, Provincial and community radios as shown in Table 2.1 and Figure 2.5. District works with INGC delegate to collect and disseminate disaster information.

Figure 2.9 shows an example of evacuation order issued by Namacurra District. It urges people in risk area to move to safer and higher areas. It also indicates specific names of the safe resettlement areas.

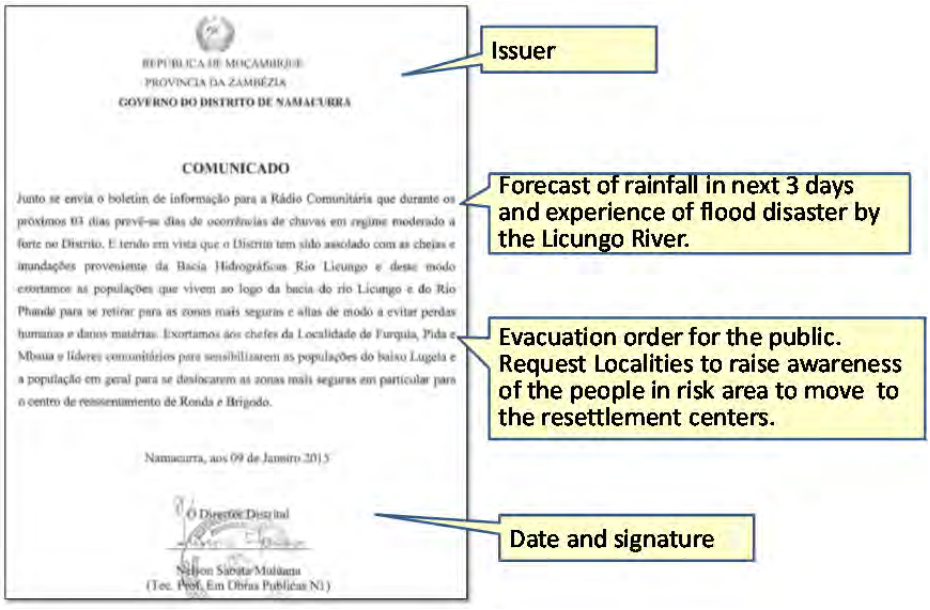


Figure 2.9 Example of evacuation order issued by Namacurra District

Recommendations

Based on the information from ARAs and DNGRH, it is recommended to use expression of sense of emergency as shown in Example 2. Also the following message is recommended to be included in order to disseminate the evacuation order to the people surely and widely:

Example 7

If you listen to this disaster information, please disseminate it to your community leaders and neighbors.

Also the short title of the release should be clearly stated as shown in Example 3.

g) Administrative Post

Administrative post receives flood warning from ARA's Unit and evacuation order from Provincial and District COE. Administrative post disseminate the flood warning and evacuation order through Regulo, community leaders, church and mosque and local committee for disaster risk management (CLGRC).

h) Locality

Localities receive flood warning and evacuation orders from Administrative Post, TV and radios. Localities disseminate flood warning and evacuation orders through community leaders and local committee for disaster risk management (CLGRC).

i) Local Committee for Disaster Risk Management (CLGRC)

Local committee for disaster risk management (CLGRC) receives flood warning and evacuation order from locality and through the radios. There are two members of the committee in charge of communication, who collect disaster information by listening radios. Two radios are provided by INGC with rechargeable batteries and solar panel.

CLGRCs are well organized. CLGRC is volunteers consist of 18 members who received trainings from INGC and Red Cross. Dissemination of flood warning and evacuation order in community has been well established by using loud speakers, whistles, drums, flags, etc.

Provincial radio is the source of information for remote community (community radio cannot cover whole district). Basically CLGRC does not use cell-phone due to its cost. Disaster warning is received in local languages from radios. The message is clear and easy for them to understand.

DRM Committee in Morla

DRM Committee in Muguloma

Community Radio in Maganja da Costa

Musaya resettlement area

DRM Committee in Furquia

DRM Committee in Brigodo

j) Radio Mozambique (Provincial Radio)

Radios play very important role in disseminating disaster information especially for remote communities in Maganja da Costa and Namacurra Districts. Radio Mozambique (Provincial Radio) receives both flood warning and evacuation orders from various agencies such as INAM, ARA-CN, ARA's Unit, Provincial and District COE/INGC and its reporters at sites. The Provincial radio disseminates flood warning and evacuation order immediately by interrupting normal program in case of emergency.

The Provincial Radio broadcast radio through FM and AM. Although listening area of FM is limited within ±50 km, that of AM can cover whole Zambezia Province. It broadcasts flood warning and evacuation order in Portuguese and other 3 local languages. Radio Mozambique Zambezia Province has MOU with government agencies and broadcast warning information free of charge.

k) Community Radio

Community radio also plays very important role for disseminating specific disaster information including the name of safe place for evacuation.

Figure 2.10 shows an example of message of evacuation order broadcasted through community radio. Community radio uses easy and simple word comparing with official announcement and the message is broadcasted in Portuguese and other local languages.

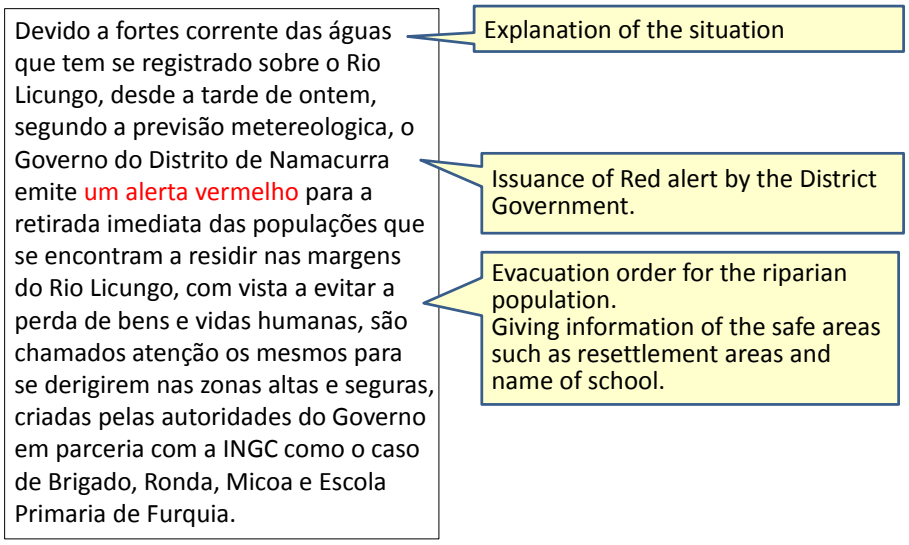


Figure 2.10 Example of Announcement by Community Radio of Namacurra

Community radio is a member of District's COE. Community radio translates the flood warning of District's COE, INGC, ARA, etc. into easily understandable short message in Portuguese and local languages. The warning message is repeated every 15 minutes in all the languages during emergency.

Listening area of community radio is area of a circle with radius 50km or less. Remote communities in Maganja da Costa and Namacurra cannot listen to community radio.

Recommendations

Community radio's message include that Namacurra District issued a red alert for immediate evacuation but it is not sure if all the people understand the meaning of red alert. If some people do not understand the meaning of the red alert, such technical term should not be used.

If the imminent hazard is large one, the easily understandable expressions should be used for people's better understanding of the magnitude of imminent hazard as shown in Example 2.

The message from the radio should include such message as "Please disseminate this information to your community leaders and neighbors" as presented in Example 7.

2.5 Challenges

Other than recommendations discussed above, the following matters should be taken into consideration:

a) People in remote communities need time to protect families and properties (at least 3 days in case of remote community). Flood information should be issued within the earliest possible time.
b) Radios are the most common means of information for communities. It is important to utilize community and Provincial radios preferentially.
c) Hydrological observations after 18:00 PM should be continued in case of emergency in all the river basins with high flood risk.
d) All the records of hydrological data and issuance of flood warning should be properly maintained.
e) All the list of contact name, phone, fax, email should be clearly indicated on paper and always updated for emergency. In case of emergency, contact list is critically important. If the list is stored in PC, it is not able to be used in case of power outage.
f) Radio communication system (such as Motorola, icom, etc.) of ARAs should be properly maintained as an alternative communication means.
g) Roles of Province and Districts are also very important to decide and issue evacuation order for the people in risk areas. Such decision should be made in short time.

3 Recommendation on Formulation of Water Related Disaster Management Plan

3.1 Concept of Integrated Water Resource Management and Integrated Flood Management

(1) Concept of Integrated Water Resource Management (IWRM)

Integrated Water Resource Management (IWRM) is the process to promote coordinated development and management of water, land and related resources in river basins, to maximize the economic benefits and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Integration of water resources management at river basin scale, in

- Spatial of integration: Geographical / Environmental interaction
  - Water use and flood protection in consideration of correlation between upstream and downstream, beneficial areas of river right and left, impact between main stream and tributaries.
- Sector Integration : One administration
  - Disaster prevention, water use, environmental protection, industry, forestry, etc.
- Stakeholder integration: Optimized benefit
  - Government at national and local, water users, private and public organization, communities, individuals, etc.

Principles in IWRM

- To understand society, history and culture
- To respect and to help other water users
- To promote public welfare
- To manage water resources based on science and technology
- To consider environmental function of water
- To strengthen government capacity
- To integrate flood management into water resources management

Water,

- Moving in the globe, re-circulating eternally
- Resourceful when it flows, not in stock
- Sustainable flow, to sustainable use
- Local resource, mal-distributed, fluctuating
- The use of water can take the other people’s opportunity to use by means of quantity and

quality

- Lack of water, not by environment nor climate, but mostly because of social discrepancy, uneven resource management and poverty

(2) Integrated Flood Management (IFM)

Integrated Flood Management (IFM) is the most important component of IWRM.

IFM requires:

- Clear and objective policies supported with legislation and regulations
- The need for a basin approach
- Institutional structure through appropriate linkage
- Community-based institutions
- Multidisciplinary approach
- Adaptive management
- Information management and exchange
- Appropriate economic instruments

Comprehensive flood control measures consist of:

- In-stream measures
  - Channel normalization
  - Flood way, diversion, polder
  - Dam, reservoir
- Watershed measures
  - Storm water retention
  - Surface water infiltration
  - Land use regulation
  - Flood proofed building
- Information measures
  - Flood forecasting, early warning
  - Public response

The general process and contents of flood disaster risk management process are as follows.

Process	Contents
1. Understanding Flood Hazard	1. Type and cause 2. Probability 3. Flood hazard assessment

2. Understanding Flood Impact	1. Direct impact 2. Indirect impact 3. Vulnerability and Risk assessment
3. Considering structural options	1. Conveyance 2. Flood storage 3. Drainage systems 4. Infiltration 5. Wetland and environmental buffers 6. Flood proofing, resilience/resistance 7. Flood defense
4. Considering non-structural options	1. Flood zoning, land use planning 2. Flood awareness campaigns 3. Health awareness 4. Solid and liquid waste management 5. Community based resilience improvement 6. Flood insurance 7. Early warning 8. Evacuation 9. Emergency response 10. Flood recovery and reconstruction
5. Evaluating alternative risk reduction options	1. Evaluating cost and benefit 2. Defining “target protection level”
6. Implementing and managing	1. Implementation 2. Sustainable maintenance 3. Community engagement
7. Reviewing and improving the management system	1. Benchmarking and monitoring 2. Reviewing and improving

3.2 2015 Licungo River Flood

In the middle of January 2015 Licungo River basin had heavy rainfall and suffered from severe flood damage. JICA Team and C/Ps conducted site survey to grasp damage situation and emergency response from 21 to 24 January in Licungo River basin. After the survey JICA Team explained the findings for future reference of water related disaster management.

(1) Rainfall and Water Level

Because hydrological stations in Mocuba and Gurue are operated by Mocuba Unit and Gurue office, C/Ps can get these data immediately. For three days from 11 to 13 January 2015, rainfall station in Mocuba recorded 233.4 mm and that in Gurue recorded 354.7 mm. Both rainfall amounts were equivalent to 20-year return period.

Water level stations in Mocuba and Gurue had some trouble and couldn’t record peak water

level unfortunately.

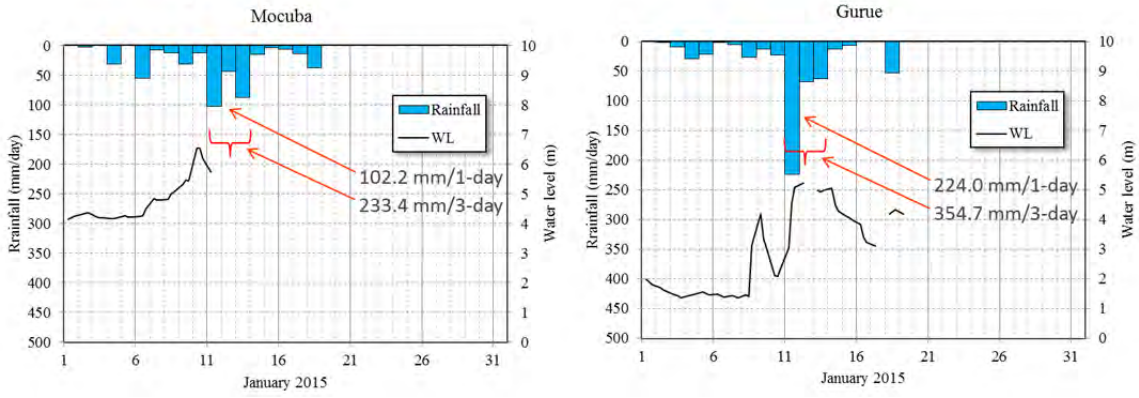


Figure 3.1 Hyeto-Hydrograph on January 2015

Table 3.1 Probability of Rainfall

Station	n-day	Rainfall	Return period
Mocuba	1-day	102.2 mm	2-5 year
	3-day	234.4 mm	20 year
Gurue	1-day	224.0 mm	25 year
	3-day	354.7 mm	20 year

(2) Flooded Area

Flooded area spread over Maganja da Costa district and Namacurra district. Because the river longitudinal profile in the downstream is very gentle, flooding flow from upstream was stagnant and overflowed there.

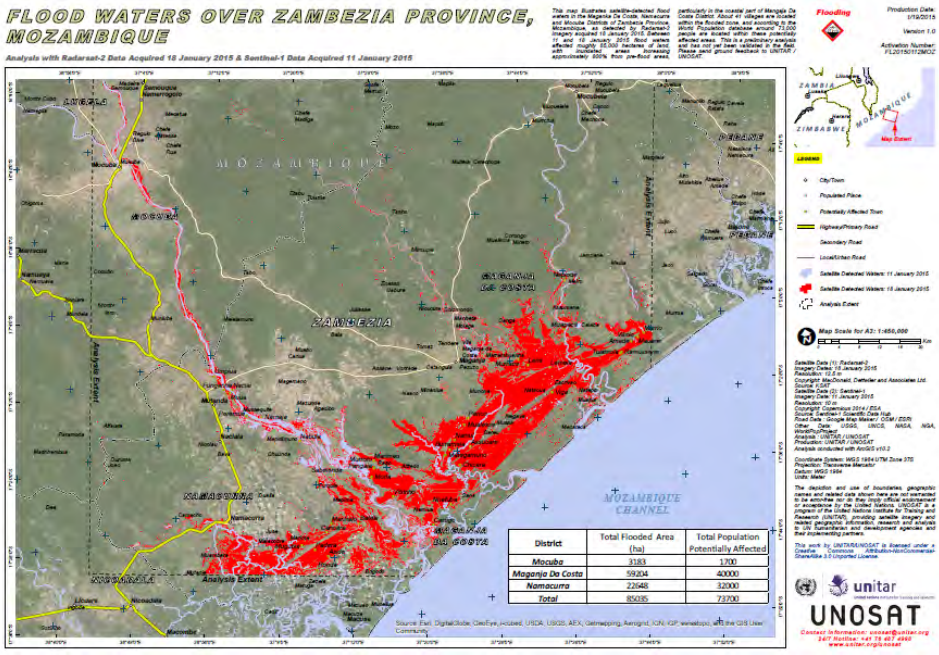


Figure 3.2 Flood Map

(3) Damage of River Structures

Rivers and river structures were damaged as follows.

<table>
<tr>
<td> 
Intake facility for water supply on outer bank of curve reach was damaged. (Lugela River)</td>
<td> 
Riverbank erosion at upstream of intake facility. (Lugela River)</td>
</tr>
<tr>
<td> 

Lugela R. Br: Some railings were washed away due to overflow but traffic is secured after cleaning the debris on the bridge.</td>
<td> 
Right bank of Lugela R. at the bridge: Some houses were destroyed due to flood flow.</td>
</tr>
<tr>
<td> 

Right bank of Lugela R. at the bridge: People waiting for a boat to cross to left bank of Licungo R.</td>
<td> 
Licungo R. Br: Right bank was eroded but bridge body is remained.</td>
</tr>
</table>

Licungo R. Br: Embankment work was started at eroded right bank.

Licungo R. Br: Embankment at left bank side was washed away and a culvert is remained.

Malei Bridge before Flood

Approach road to Br-1: Crown of embankment was eroded due to overflow

Approach road to Br-1: Crown of embankment was eroded due to overflow

Br-1: Main body is remained but approach roads of the both side were washed away

Br-1: Eroded approach road on right bank side

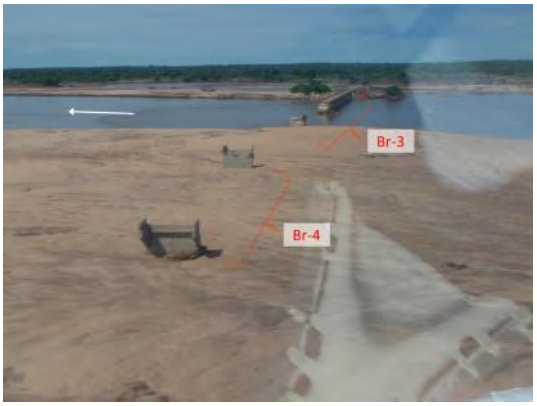
Br-2: Abutments are remained but other portions were washed away

Br-2: Dropped bridge beam

Br-3: 6 spans of right bank side are remained but beams and piers of other 3 spans were washed away.

Br-3: Bank on right bank side was eroded

Br-3: Abutment on right bank side



Br-4: Portions except abutments were washed away and embankment between Br-3 and Br-4 was also washed away

Inundated area widely spreads between Licungo River and relatively higher land, where Nante post office is located

Extensive paddy field are under water

(4) Response of Community and Emergency Operation Center

According to interview with resident in Furquia and Namacurra district office, their response during flood is as follows.

- Flood warning and evacuation instruction were issued to residents but many residents did not evacuate because they thought that the flood was usual or the warning was not credible.
- Some people evacuated on the trees for 4 days.
- Flood damage this time was the severest since 1971. This flood was severer than one in 1971.
- District Disaster Risk Council has been organized every day since 12 January to collect and share information for disaster response.
- Time series of events and activities are summarized as follows.

Date	Events/Activities
Jan.10/11	Namacurra District received information of heavy rains at Gurue and Dorocue
Jan.12 06:00	Water level of Malei was already high. Flood warning was disseminated to the risk communities.
Jan.12 15:00	Inundation was already started in Muiribere, Furquia, and Bawa.

- Emergency Operation Center (EOC) in Quelimane was established in the Government Office of Zambezia Province based on the guideline on establishment and functioning of CENOE.
- The Director General of INGC was assigned as the Service Officer of EOC and under the Service Officer, five groups were formed, i.e. 1) information and planning, 2) communication, 3) infrastructure, 4) procurement and logistics, and 5) social affairs.

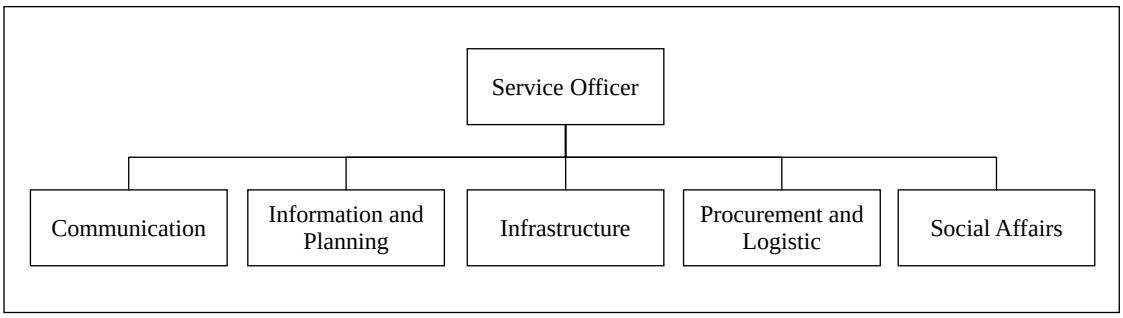


Figure 3.3 Structure of Emergency Operation Center

3.3 Water Related Disaster Risk Management Plan

JICA Team instructed C/Ps of ARA-CN, which is in charge of river management under the jurisdiction, how to examine water related disaster risk management plan. The flow of formulation of integrated flood management plan is illustrated in Figure 3.4. For each component, JICA Team explained it, C/Ps examined and made presentation, and all of them discussed.

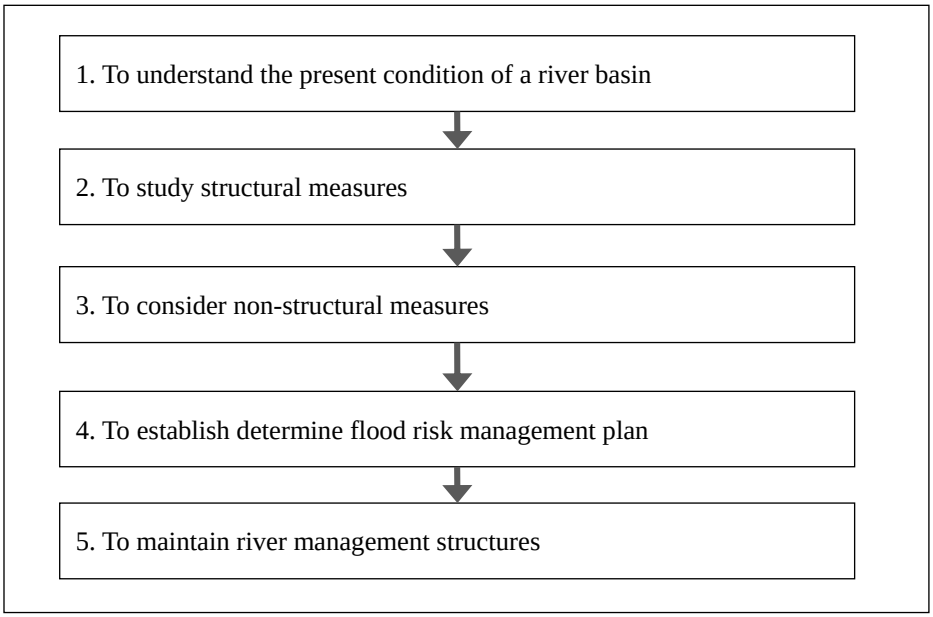


Figure 3.4 Flow of Formulation of Integrated Flood Management

(1) To Understand the Present Condition of a River Basin

(i) Base map

To prepare the base map using Google Earth for study on water related disaster management plan. First, put marks, path and polygon for relevant offices, river structures, hydrological stations, river, dike lake, etc. The base map was made as KML file, which can be shared among other computers.

(ii) Present condition of Licungo River basin

- Licungo River has main tributary named Lugela River, which joins Licungo River in Mocuba. The river basin widely spreads in the upstream of Mocuba. On the other hand, the river basin is confined along the river.
- In the lower reach, the river meanders and forms sandbar on riverbed.
- There are a lot of bridges across Licungo River and the tributaries. Many of them were damaged due to 2015 Flood.
- River bank erosion occurs in many places.
- The stretch from 2 to 8 km downstream from Mocuba Bridge consists of rock riverbed.
- The highest altitude of the river basin is more than 1,500 m in northern area of the basin.
- The upstream of Mocuba is mountainous area. So river must flow much fast. Sediment disaster often occurs at this area.
- During flood Licungo River transports so much sediment from the upper basin to the sea.

- Hilly area lies along the coastline. It hinders inundated water from smoothly draining to the sea.

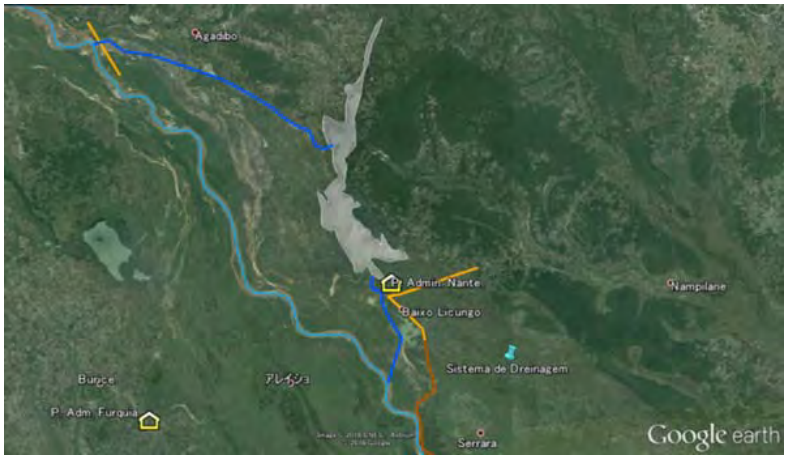
(iii) 2015 Flood in Licungo River (Findings from the flood map)

- Licungo River overflowed in the downstream where the river forms meandering course.
- Overflowed water at Nante, Maganja da Costa district partially flowed into Tantamela Lake through small channel. It meant Tantamela rolled a natural retarding pond.
- Malei Bridge was washed away. The causes were lack of clearance from water level, river bank erosion, riverbed scouring, etc.
- The upstream from Nante did not suffer from inundation. Because the ground elevation was relatively high compared with riverbed.

(2) To Study structural Measures

C/Ps examined structural measures considering situation/damage by the 2015 flood, presented the idea individually, and finally united one structural plan.

- Dams in upstream of Licungo and Lugera rivers
- Inlet and outlet channels connecting Licungo River and Tanta-mera (lake)
- Extension of dike in Nante
- Drainage system in irrigation area in Nante
- Bank protection works around the bridges



Location Map of Structural Measures on Base Map

(3) To Consider Non-structural Measures

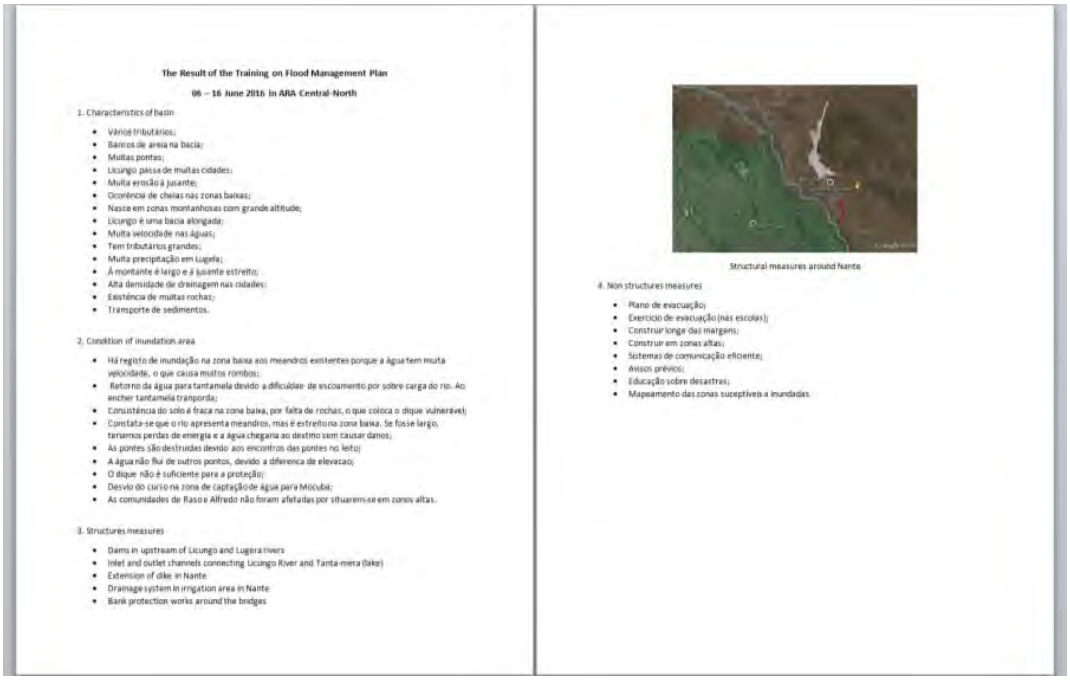
C/Ps also examined non-structural measure, e.g. evacuation plan, land use plan, early warning system, etc. JICA Team explained that easily understandable warning message to community is critical for early warning system because the purpose of early warning system is to reduce flood damage and save people's lives.

- Evacuation plan
- Evacuation exercise in schools
- Building restriction near the river bank
- Efficient communication systems
- Flood early warning
- Disaster education
- Flood hazard map

(4) To Establish Determine Flood Risk Management Plan

C/Ps integrated flood risk management plan for Licungo River uniting the above structural and non-structural measures. In the future, it is recommended to make a plan adding the following studies.

- This plan was examined as countermeasures against 2015 flood. It is recommended to consider other flood of different scale, e.g. 100-year or 200-year return period floods.
- Best mix of structural measures and non-structural measures is examined by economic analysis.
- Hydraulic analysis will applied for decision of structural measures.



The Result of the Training on Flood Management Plan

06 – 16 June 2016 in ARA Central-North

1. Characteristics of basin

- Vários tributários;
- Bancos de areia na bacia;
- Muitas pontes;
- Licungo passa de muitas cidades;
- Muita erosão à jusante;
- Ocorência de cheias nas zonas baixas;
- Nasce em zonas montanhosas com grande altitude;
- Licungo é uma bacia alongada;
- Muita velocidade nas águas;
- Tem tributários grandes;
- Muita precipitação em Lugela;
- À montante é largo e á jusante estreito;
- Alta densidade de drainagem nas cidades;
- Existência de muitas rochas;
- Transporte de sedimentos.

2. Condition of inundation area

- Há registo de inundação na zona baixa aos meandros existentes porque a água tem muita velocidade, o que causa muitos rombos;
- Retorno da água para tantamela devido a dificuldade de escoamento por sobre carga do rio. Ao encher tantamela tranporda;
- Consistência do solo é fraca na zona baixa, por falta de rochas, o que coloca o dique vulnerável;
- Constata-se que o rio apresenta meandros, mas é estreito na zona baixa. Se fosse largo, teriamos perdas de energia e a água chegaria ao destino sem causar danos;
- As pontes são destruidas devido aos encontros das pontes no leito;
- A água não flui de outros pontos, devido a diferença de elevacao;
- O dique não é suficiente para a proteção;
- Desvio do curso na zona de captação de água para Mocuba;
- As comunidades de Raso e Alfredo não foram afetadas por situarem-se em zonas altas.

3. Structures measures

- Dams in upstream of Licungo and Lugera rivers
- Inlet and outlet channels connecting Licungo River and Tanta-mera (lake)
- Extension of dike in Nante
- Drainage system in irrigation area in Nante
- Bank protection works around the bridges

Structural measures around Nante

4. Non structures measures

- Plano de evacuação;
- Exercício de evacuação (nas escolas);
- Construir longe das margens;
- Construir em zonas altas;
- Sistemas de comunicação eficiente;
- Avisos prévios;
- Educação sobre desastres;
- Mapeamento das zonas suceptiveis a inundadas.

(5) To Maintain River Management Structures

River structures should be maintained properly and the function of each structure must be kept. For this maintenance activity, inventory of river structures is indispensable. The inventory consists of inventory sheets and base map.

- Inventory sheet is prepared as one PDF file for each river management structures.
- Contents to be described in an inventory sheet are name, ID number, jurisdictional office, river basin, river, location, coordinates, type of structure, start date of operation, status of operation, alert level, observer (name and contact number), damage history, etc.
- Base map is prepared using Google Earth.
- Symbol or object expressing each structure is put on Google Earth. For example, dike is expressed as a line; a bridge is shown as an alphabet "B"; rainfall station is illustrated as a star symbol.
- Each symbol or object is linked to a corresponding inventory sheet. The inventory sheet appears by clicking the symbol or object.

The purpose of the inventory of river management structures is neither preparing inventory sheets nor making base map. It is maintaining river management structures though early detection and repair utilizing the inventory. So, it is strongly recommended that C/Ps make efforts to prepare inventory sheets for all structures as soon as possible and start regular inspection in parallel.

4 Recommendation on Human Resources and Institutional Development

This chapter provides recommendations on human resource and organizational development for improvement of the water-related disaster management capacity of DNGRH and ARAs, the central institutions of water resources management in Mozambique.

At the start of the project, the JICA team conducted a baseline survey in order to grasp the current situation of human resource development and organizational structure of DNGRH and ARAs. As a result, although training on the topic of water supply and sanitation were conducted, it has been found that training related to river administration or flood risk management has not been implemented. Regarding the organizational system, it can be considered that there is room for improvement as a central institution responsible for river administration and flood management.

It is recommended that DNGRH and ARAs enhance human resource and organizational development based on the recommendations presented here.

4.1 Human Resources Development

The JICA Team has grasped the current training courses of the Human Resources Division of DNGRH during the baseline survey. Almost all the trainings conducted by the Division were on the topic of water supply and sanitation. The trainings do not include the subject on flood management topic.

Department of Water Resources has been receiving trainings supported by World Bank since 2012 through the framework of the Pilot Program for Climate Resilience (PPCR) and the National Water Development Program (PNDRH). The proposed trainings include some flood management topics but most of them are on some specific topics of flood management, not comprehensive one.

Major Proposed Trainings of DNGRH relating to Flood Management supported by World Bank

- Hydrological data collection and processing
- Urban flood management
- Hydro-Mechanics
- GIS and remote sensing for water resources management
- Dam safety

According to the results of the capacity assessment workshop at ARA Central North in May 28, 2015, insufficiency of technical capacity of the staff in various phases of flood management were stated by the participants in the workshop. It is essential for the engineers and technicians of DNGRH and ARAs to have comprehensive knowledge on river administration and integrated flood

management.

On the other hand, Training of Hydrological & Hydraulic Trainers and IFAS & Auto IFAS Modeling Trainers were implemented and six trainers were cultivated from DNGRH and ARA-Sul as one of the main activities of the Project. It is strongly recommended that the trainers will conduct the trainings for other engineers and technicians of DNGRH and ARAs for expansion of the knowledge and skills on hydrology and effective usage of IFAS and Auto IFAS.

Therefore, regarding human resources development, this recommendations report discuss about the following two kinds of trainings:

- Training on River Administration and Integrated Flood Risk Management
- Training of Hydrological & Hydraulic Trainers and IFAS & Auto IFAS Modeling Trainers

(1) Training on River Administration and Integrated Flood Risk Management

(i) Concept of the Training

This training on river administration and integrated flood risk management has been designed so that engineers and technicians of DNGRH and ARAs can acquire comprehensive knowledge on basic of river administration and integrated flood risk management. The training plan has been prepared to cover understanding basic of river administration, flood hazard, flood impact, structural measures, non-structural measures, evaluation of the project, determination of target protection level, implementation of integrated flood risk management, and reviewing and improvement of the management system. Based on this training plan, DNGRH and ARAs can plan and implement training on basic river administration and integrated flood risk management.

Since the training institution or financial source of this training program has not been decided yet, the concept, syllabus and contents of the training should be clearly understood by any institution that implements this training. And it is also very important to secure the quality of training. Therefore, the part of integrated flood risk management of this training plan is prepared based on one of the standard guides of integrated flood risk management, "Cities and Flooding", a Guide to Integrated Urban Flood Risk Management for the 21st Century, Abhas K Jha/ Robin Bloch/ Jessica Lamond, the World Bank". Although the guide focuses partly on urban flood risks but the basic concept is applicable for both urban and non-urban flood risks. By referring the guide, the contents of the training can be standardized.

Since the training plan has been prepared to acquire comprehensive knowledge on integrated flood risk management, for learning in depth specific techniques such as river modeling, GIS, etc., a separate training should be implemented.

According to the official in charge of human resources development of the Administrative Division of DNGRH and another official in charge of the training project supported by the World Bank Project, there is no training institution that can conduct training on flood risk management in Mozambique. But there are several universities such as Kwazul Natal University, Rhodes University, etc. in South Africa, which has specialty in hydrology and can conduct the such trainings

Flow of the training program is as shown in Figure 4.1.

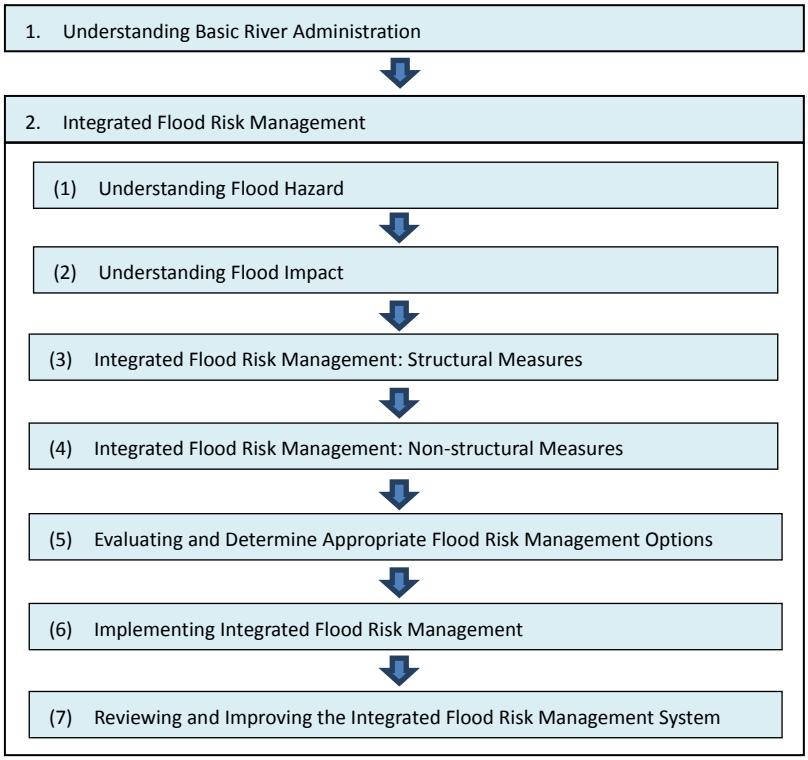


Figure 4.1 Flow of Training Program for Integrated Flood Risk Management

(ii) Proposed Training Program

The training program has been prepared as shown in Table 4.1. The training hours are proposed temporarily as indicated in the table, but it can be properly adjusted at the time of actual implementation. The program should be implemented not only by lectures but also by exercise and group discussions.

Table 4.1 Training Program on River Administration and Integrated Flood Risk Management

	Module	Program	Hours
A		Understanding River Administration	12 hours
	0.1	Social engineering knowledge	(2 days)
	0.2	Engineering knowledge	
B		Integrated Flood Risk Management	12 hours
B-1		Understanding Flood Hazard	(2 days)
	1.1	Type and cause	
	1.2	Probability of flooding	
	1.3	Flood hazard assessment	
	1.4	Climate change and sea level rise	
B-2		Understanding Flood Impact	12 hours
	2.1	Direct impact	(2 days)
	2.2	Indirect impact	
	2.3	Vulnerability and Risk assessment	
B-3		Integrated Flood Risk Management: Structural Measures	12 hours
	3.1	Conveyance	(2 days)
	3.2	Flood storage	
	3.3	Drainage systems	
	3.4	Infiltration	
	3.5	Wetland and environmental buffers	
	3.6	Flood proofing, resilience/ resistance	
	3.7	Flood defense	
B-4		Integrated Flood Risk Management: Non-structural Measures	18 hours
	4.1	Flood zoning, land use planning	(3 days)
	4.2	Flood awareness campaigns	
	4.3	Health awareness	
	4.4	Solid and liquid waste management	
	4.5	Flood insurance	
	4.6	Early warning system	
	4.7	Evacuation	
	4.8	Emergency response	
	4.9	Flood recovery and reconstruction	
B-5		Evaluating and Determine Appropriate Flood Risk Management Options	12 hours (2 days)
	5.1	Evaluating cost and benefit	
	5.2	Defining "target protection level"	
B-6		Implementing Integrated Flood Risk Management	18 hours
	6.1	Implementation	(3 days)
	6.2	Community engagement	
	6.3	Community-based measures to increase resilience	
	6.4	Financing flood risk management measures	

	6.5	Sustainable maintenance system	
	6.6	Preventing failure: effective monitoring systems and protocols	
	6.7	Evaluation	
B-7		Reviewing and Improving the Integrated Flood Risk Management System	6 hours (1 day)
	7.1	Twelve key principles for integrated flood risk management	
	7.2	Integrated flood risk management process	
	7.3	Benchmarking and monitoring	
	7.4	Reviewing and improving	
		Total:	102 hours (17 days)

(iii) Proposed Syllabus of the Training Program

Syllabus of the training has been prepared so that engineers and technicians of DNGRH and ARAs can acquire comprehensive knowledge on basic of river administration and integrated flood risk management as presented below:

A. Understanding River Administration

Title	1. Understanding River Administration
Description of the Program	In recent years, flood disasters have occurred more frequently and been more enormous because of climate change, land development, urbanization, etc. In order to tackle such flood disasters caused by uncertain factor, administrative officers have to consider legal, administrative, social and engineering aspects. The Program deals wide and basic knowledge of river administration for future training.
Objective	- To understand social engineering knowledge for integrated flood management, e.g. policy of disaster mitigation, disaster management, reginal disaster management plan, etc. - To understand engineering knowledge for integrated flood management, e.g. hydrological cycle, river morphology, climate change, etc.
Duration	12 hours (2 days)
Program	1) Social engineering knowledge ・Social system against flood disasters ・Policy and regal for flood management ・Policy making process ・Conflict management for international rivers ・Consensus building (Project Cycle Management) 2) Engineering knowledge ・Basic concept of Integrated Flood Risk Management ・Disaster management cycle ・Hydrological cycle

	・River morphology ・Climate change and effect for flood
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B. Integrated Flood Risk Management

B-1 Understanding Flood Hazard

Title	1. Understanding Flood Hazard
Description of the Program	Floods are natural phenomena, but they become a cause for serious concern when they exceed the coping capacities of affected communities, damaging lives and property. It is necessary to understand flood hazards in order to perform proper prevention, mitigation, preparation and damage reduction activities. The Program deals the types and sources of flooding, and their frequency and probability. Ways of quantifying and assessing the flood hazard are then highlighted. The issue of dealing with changing flood hazard due to anticipated climate change is discussed.
Objective	- To understand flood hazard which is essential for prevention, mitigation, preparation and damage reduction activities - To acquire knowledge of the types and causes of flooding, probability of occurrence, flood hazard modeling and mapping, and influence of anticipated climate change
Duration	12 hours (2 days)
Program	1) Type and cause River floods, urban floods, flash floods, etc. 2) Probability of flooding Probability of occurrence of floods, uncertainties in flood probability estimations. 3) Flood hazard assessment Data requirements for flood hazard assessment, preparation of flood hazard map. 4) Climate change and sea level rise Potential impacts of climate change, incorporating climate change scenarios in probability analysis and flood risk management.
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-2 Understanding Flood Impact

Title	2. Understanding Flood Impact
Description of the Program	In this program, risks to life, health, buildings, infrastructure and other properties caused directly or indirectly by flood water are discussed. How to perform a damage assessment is also discussed. Other effects of flooding, including the impacts on the natural environment and longer-term human and social impacts (including effects on demography, economic, political and institutional impacts),

	psychological and mental effects of flooding on people are also discussed. Various options for assessment of risk and vulnerability, together with approaches to mapping, and includes discussion of the types and sources of data required are also discussed. Categories of vulnerability and the factors affecting their rate of exposure are presented. How to undertake a vulnerability assessment is explained.
Objective	- To understand the direct and indirect impact of floods - To acquire knowledge how to conduct flood damage assessment, vulnerability assessment, vulnerability mapping, flood risk mapping, etc.
Duration	12 hours (2 days)
Program	1) Direct impact Impact to residents, buildings and contents, crops and animals, cascading impact, flood damage assessment. 2) Indirect impact Natural environment, human and social impacts, economic and financial impacts, others. 3) Vulnerability and Risk assessment Assessing vulnerability, vulnerability map, flood risk map
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-3 Integrated Flood Risk Management: Structural Measures

Title	3. Integrated Flood Risk Management: Structural Measures
Description of the Program	Integrated flood risk management, which includes both structural and non-structural management measures, is required to reduce flood risk. This program focuses on structural measures that are used to control the flow of water, within the context of an integrated approach for flood risk management. The measures include structural solutions such as river improvement, retarding basin, drainage channels, wetlands and natural buffers, etc. The program gives an overview of integrated flood risk management options by both structural and non-structural measures. Then the program explains structural measures in detail. It describes the purpose of conveyance, which is the provision of a route to take potential floodwater away from areas at risk. Flood storage measures aimed at reducing the peak of flood flows are discussed. Drainage systems and infiltration are also discussed. Utilization of wetlands and environmental buffers are also considered as measures to reduce the amount and speed of rainwater runoff in areas. Flood proofing by the design of buildings that can reduce their vulnerability to flood impact is discussed. Then, flood defense measures that aim at reducing the risk from flooding of people and the developed and natural environment are discussed.
Objective	- To acquire knowledge on various structural measures those are used to control the flow of water, within the context of an integrated approach for flood risk management. - To understand effectiveness of wetlands and environmental buffers

	- To understand flood proofing and flood defense to reduce flood risks
Duration	12 hours (2 days)
Program	1) Conveyance Modification of river, flood relief channel, floodplain restoration, other 2) Flood storage On-line and off-line storage, temporary storage in urban area, other 3) Drainage systems Sewers and drains, major and minor drainage systems, interface with river system, semi-natural system, surface water management plan, etc. 4) Infiltration 5) Wetland and environmental buffers 6) Flood proofing, resilience/resistance 7) Flood defense
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-4 Integrated Flood Risk Management: Non-structural Measures

Title	4. Integrated Flood Risk Management: Non-structural Measures
Description of the Program	The Program focuses on non-structural measures applied for flood risk management. The measures do not require large investment for infrastructures, but rely instead on a good understanding of flood hazard and adequate forecasting systems. The program discusses non-structural measures in terms of four principal purposes: preparing for flooding, avoiding flooding, planning for and managing flood emergencies, and recovering from flooding. Awareness rising of flooding through campaigns which minimize the impacts of floods and health awareness campaigns to reduce harmful impact on public health contributes to enhance preparedness. The program also discusses land use planning for avoidance of flood risk and reduction of impacts, and incorporation of flood zoning into land use planning procedures. Then we discuss flood insurance, risk financing, compensation and tax relief which serve to reduce or transfer risk and damage through risk assessment. The program also covers the crucial practice of solid and liquid waste management. The program then discusses emergency planning, rescue and temporary shelter measures. Business including government continuity planning, early warning systems; evacuation planning, flood recovery and reconstruction methods and processes are also dealt in the Program.
Objective	- To understand non-structural measures such as flood zoning and land use planning, flood awareness campaigns, health awareness, solid and liquid waste management, flood insurance, early warning system, BCP, evacuation, emergency response, flood recovery and reconstruction, etc. for flood risk management
Duration	18 hours (3 days)
Program	1) Flood zoning, land use planning

	Land use planning and flood risk management, integrating land use planning and flood risk management, how to produce land use plans that incorporate flood risk management 2) Flood awareness campaigns Awareness campaign design, communication channel, monitoring awareness 3) Health awareness Necessity of health awareness campaigns, key components of health awareness campaigns, benefits, how to conduct a health awareness campaign 4) Solid and liquid waste management Management of solid waste, management of liquid waste and drainage, 5) Flood insurance Level of insurance coverage, requirements for market-based insurability, danger of adverse selection and moral hazard, micro-insurance, risk financing mechanism, compensation and tax relief schemes, essential considerations to support the introduction of effective flood insurance 6) Early warning system (EWS) Effective early warning system, flood warning dissemination, appropriate message content 7) Evacuation Organizational aspects of evacuation planning, provision of flood shelters and refuges, location and size of shelters and refuges, water supply and sanitation facilities, stockpiles of materials, communication system, 8) Emergency response Emergency planning, damage avoidance, flood emergency preparedness activities, evacuation and rescue, business and government continuity planning (BCP) 9) Flood recovery and reconstruction Access and solid waste clearance, mitigating damage, assessment and prioritization of needs, post-disaster reconstruction and resettlement, how to restore flood damaged buildings,
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-5 Evaluating and Determine Appropriate Flood Risk Management Options

Title	5. Evaluating and Determine Appropriate Flood Risk Management Options
Description of the Program	The impacts of flooding can be devastating and deadly, resulting in the need to manage the risks of flooding by governments, municipalities, communities and individuals. The various measures or solutions which are available to manage flood risks. Government decisions about implementation of flood risk management need to be balanced against other national priorities. This program focuses on evaluating costs and benefits in monetary terms using Cost Benefit Analysis (CBA). It is also important to take a broader view and consider the effect of flood risk management that cannot be quantified. This need

	can be addressed by the use of Multi-Criteria Analysis (MCA). It is also necessary to determine the acceptable level of flood risk and to decide between alternatives, while taking account of wider policy, equity, social issues, and uncertainties.
Objective	- To acquire knowledge on Cost Benefit Analysis (CBA), Multi-Criteria Analysis (MCA) and consideration of Operation and Maintenance (O&M) cost, which are all important for decision making of a project implementation. - To acquire knowledge on how to define "target protection level".
Duration	12 hours (2 days)
Program	1) Evaluating cost and benefit Cost benefit analysis, multi-criteria analysis (MCA) of cost benefit and socio-environmental issues, operation and maintenance cost 2) Defining "target protection level" Acceptance of risk 'As Low As Reasonably Practical' principle, opportunity cost, the value of a life, demands of insurability, benchmarking and regional cross-cooperation, decisions under uncertainty, no regret solutions, flexible solutions, decision trees
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-6 Implementing Integrated Flood Risk Management

Title	6. Implementing Integrated Flood Risk Management
Description of the Program	This program discusses the process of implementing integrated flood risk management which combines structural and non-structural measures. In implementing an integrated approach, the role of well-functioning institutions, the participation of stakeholders, and the engagement of communities are vital. Implementation also requires sustainable arrangements for financing. Maintenance of the implemented measures, preventing their failure, and evaluating their utility are also keys for successful implementation. The program covers the role of formal and informal institutions, involvement of stakeholders, and public-private cooperation for flood risk management. It discusses the important role of community engagement in flood preparedness and mitigation, the application of community-based measures to enhance resilience. It also deals the financing for flood risk management, operation and maintenance of both structural and non-structural measures, the monitoring of projects and processes to prevent failure, and the evaluation of flood risk management measures.
Objective	- To acquire basic knowledge for implementation of integrated flood risk management measures such as role of institutions and stakeholders, community engagement, financing, operation and maintenance system, monitoring system to prevent failures, and evaluation system.
Duration	18 hours (3 days)
Program	1) Implementation

	Role of institutions, how to perform institutional mapping, linking flood risk management with urban governance and management, allocation of stakeholder responsibilities for flood risk management, public-private cooperation 2) Community engagement Importance of community involvement, stakeholders involved in community engagement, understanding local knowledge and capacities, sharing of information and knowledge, how to engage local communities in flood risk management 3) Community-based measures to increase resilience Key components, when and where to use Community-Based Measures, benefits and drawbacks of the Community-Based Measures 4) Financing flood risk management measures Financing integrated flood risk management, grants and Loans from international development funds, climate change adaptation schemes, insurance measures including government, private and micro-insurance schemes, foreign direct investment, Public-Private-Partnerships (PPP), incentives for individual private investment, integration of policies and activities, charitable funding, market-based loans, and microfinance 5) Sustainable maintenance system Operation and maintenance considerations for structural works, maintenance of flood prevention infrastructure, waste management and drain cleaning, planning regulation, enforcement and integration of policies and activities, financing operations and maintenance 6) Preventing failure: effective monitoring systems and protocols Failure routes, hard engineered defenses, drainage systems, forecasting and early warning systems, emergency procedures, land use planning regulations, and environmental monitoring 7) Evaluation Design of evaluations, measuring and analyzing impact, Benefit-Cost Ratio, distribution of benefits (gender and cultural aspects), evaluation feedback for improving future project design and implementation.
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

B-7 Reviewing and Improving the Integrated Flood Risk Management System

Title	7. Reviewing and Improving the Integrated Flood Risk Management System
Description of the Program	This program summarizes the essential considerations for the integrated flood risk management discussed so far. It addresses the questions of how to initiate integrated flood risk management and how to calculate progress towards an effective integrated flood risk management framework. Evaluation and benchmarking are important steps in improving the design and implementation of flood risk management measures, both structural and non-structural.

	This program starts with 12 principles for integrated flood risk management. Then it focuses on a five-step process to integrate flood risk management. The benchmarks are set out for the 12 principles of integrated flood risk management. The benchmarks are designed to test progress towards the full integration of structural and non-structural measures, involving multiple stakeholders and within wider management in the longer term. This is helpful for discussions regarding the setting of future targets for the improvement of the integrated flood risk management.
Objective	- To understand how to monitor the progress of the integrated flood risk management by applying benchmarks and identify what is required to advance towards a more integrated solution for improvement of the flood risk management.
Duration	6 hours (1 day)
Program	1) Twelve key principles for integrated flood risk management Remind of the principles for integrated flood risk management. 2) Integrated flood risk management process Five-step process to integrate flood risk management 3) Benchmarking and monitoring Benchmarks in the development of better flood risk management, in alignment with the twelve principles and the five stages of delivery 4) Reviewing and improving Based on the benchmark table discussed above, review the work that has been done in a particular area, identify how far they have met the principles at that stage, and thereby establish what is required to advance towards a more integrated solution.
Profile of Participants	Engineers and technicians of DNGRH, ARAs and concerned institutions in charge of flood risk management.

(2) Training of Hydrological & Hydraulic Trainers and IFAS & Auto IFAS Modeling Trainers

(i) Concept of the Training

The training of hydrological & hydraulic trainers and IFAS & Auto IFAS modeling trainers were implemented by JICA Expert in charge of river management technology as one of the key project activities. Six engineers of DNGRH and ARA-Sul were trained as trainers.

The main objectives of the training were improvement of understanding of hydrological and hydraulic phenomena and development of knowledge and skill to utilize satellite rainfall data, IFAS, Auto IFAS, and improvement of early alert system.

IFAS (Integrated Flood Analysis System): IFAS is a concise flood-runoff analysis system

as a toolkit for more effective and efficient flood forecasting in developing countries developed by ICHARM - Japan. IFAS can utilize both ground-based and satellite rainfall data. Therefore, it is suitable for the developing countries which usually have very limited ground-based rainfall observations. Auto IFAS enables to display useful information for early warning system such information as hydrograph, dynamic maps and disseminating alert emails.

Trainees can acquire the following knowledge and skills:

- Basics of hydrology and hydraulics necessary for flood management,
- Characteristics and importance of hydrological observation data,
- Methodology to elaborate and utilize a discharge rating curve and its importance,
- Methodology to utilize satellite-based rainfall data,
- Establishment and calibration of IFAS and Auto IFAS model, and instruction method,
- Related techniques of establishment of the model including GIS application,
- Methodology to set alert level and its importance, and
- Operation and maintenance of the early warning system (Auto IFAS)

(ii) Proposed Training Program

The training program has been actually applied for the training of the trainers during the Project and had a good reputation from the participants. The training program is as shown in Table 4.2.

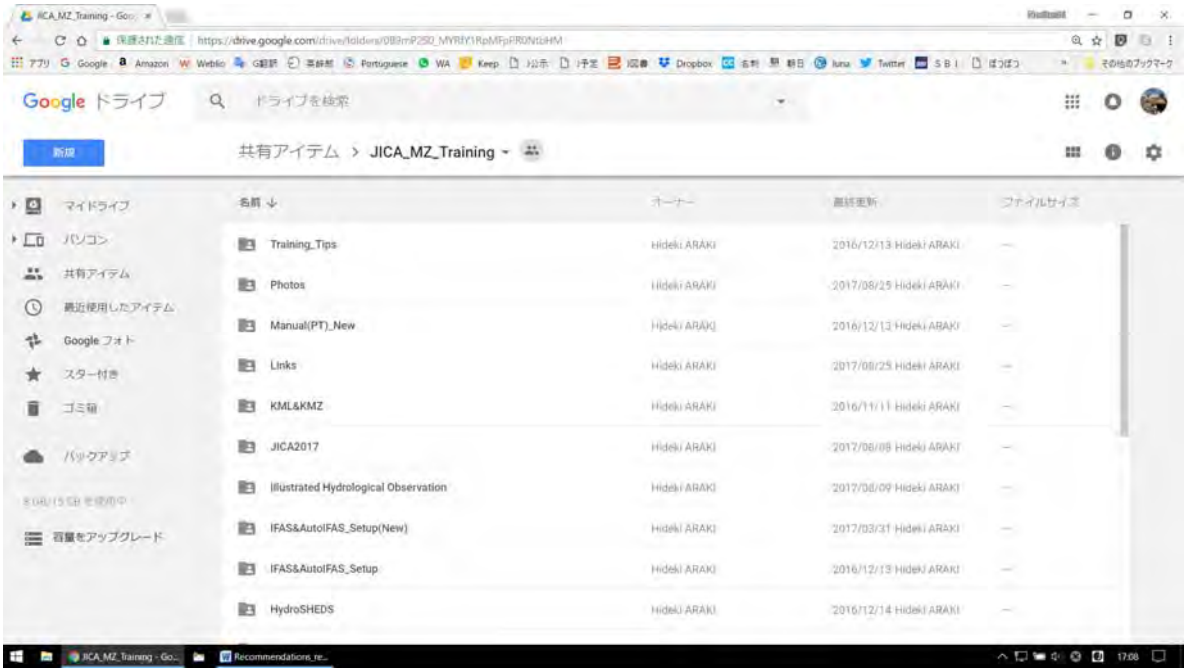
Table 4.2 Training Program (Training of Hydrological & Hydraulic Trainers and IFAS & Auto IFAS Modeling Trainers)

Day	Subject	Remarks
Day 1	• Guidance of Training course • Outline of Auto IFAS, Auto Rain Download , IFAS, GSMaP, GFAS, QGIS, Google Earth Pro, VMware • Review of available manuals • How to get required free software • Self-practice of checking PC's hardware capabilities (CPU, RAM, HDD, OS, Language setting) • Self-practice of software installation	Lecture and Self-practice
Day 2	• Review and learn on software installation problem • Self-practice of software installation and IFAS modelling • Error handling for IFAS modeling	Lecture and Self-practice

Day	Subject	Remarks
Day 3	• Lecture on Hyetograph, Hydrograph, H~Q relation, Uniform flow vs Non-uniform flow, Steady flow vs Unsteady flow • Understanding the hydrological observation network and available data (rainfall, water-level and discharge) in Mozambique • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (1/3): using observed data • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (2/3): using uniform flow calculation result	Lecture and Self-practice
Day 4	• Application of MIKE11 for cross-section's A and R • Preparation of H~Q relation at Mocuba Bridge (Station E-91) (3/3): using 2D flow simulation results • IFAS calibration (1/2)	Lecture and Self-practice
Day 5	• IFAS calibration (2/2)	Self-practice
Day 6	• Overall Auto IFAS setup • Auto IFAS setting on E-mail alert delivery • Auto IFAS test run	Self-practice
Day 7	• Auto IFAS operation drill using 2015 flood event • Discussion and preparation of alarm level • Discussion and preparation of alarm delivery protocol • Practice of alarm delivery protocol • Preparation of 1 day Training program (for Day 09)	Lecture, Self-practice and discussion
Day 8	• Case study on Operation and Maintenance of Auto IFAS ➢ Power failure ➢ Network failure ➢ Error messages • Auto IFAS outputs review • LAN setting for GSMaP data download in DNGRH • Overall review	Lecture and Self-practice Trainees will organize 2 days training as trainer.
Day 9	Training Practice for IFAS and Auto IFAS modelling	Inviting 4 beginner trainees from DGBH and ARA-Sul.

All the manuals, materials and data used for the Training of Hydrological & Hydraulic Trainers and IFAS & Auto IFAS Modeling Trainers are stored on Google Drive so that all the trainers can utilize the materials any time through internet.

(https://drive.google.com/drive/folders/0B9mP2S0_MYRfY1RpMFpPR0NtbHM)



It is strongly recommended that the trainers conduct the trainings for other engineers and technicians of DNGRH and ARAs for expansion of the knowledge and skills on hydrology, hydraulics and effective use of IFAS and Auto IFAS.

4.2 Organizational Development

(1) New Organization of the Ministry of Public Works, Housing and Water Resources

In July 2015, the new organization of the Ministry of Public Works, Housing and Water Resources was officially decided by the Resolution No.19/2015.

According to the Resolution, the duties of the Ministry are described as follows:

a) Direction and planning of the public works, ensuring the effectiveness of the investments;
b) Quality control of the public works, to ensure safety and durability;
c) Construction, rehabilitation and maintenance of the public infrastructures, namely roads and bridges, water supply system, sanitation, retention, protection and storage of water;
d) Definition of the system of design, execution and supervision of the public works;
e) Regulation of the use of the quality control of materials and construction elements;
f) Promotion of the construction industry;
g) Management of the public network of roads and bridges;
h) Guarantee of the sustainable development, unity and complementarity of the national road network;

i) Creation and development of the normative conditions and infrastructures of housing access;

J) Promotion and support of the construction programs for social housing;

k) **Implementation of policies and strategies for exploitation, rational use and sustainability of water resources;**

l) **Evaluation of water resources, determination of the needs at river basin level;**

m) **Availability of water in quantity and quality for responding the challenge for socio-economic development;**

n) **Management of water resources, ensuring its best use and exploitation in a rational and sustainable way, as well as for prevention and mitigation of the impacts of floods and droughts;**

o) **Implementation of policies and strategies for better use of services of water supply and sanitation; and**

p) **Guarantee universal access to water supply and sanitation.**

The new structure of the Ministry of Public Works, Housing and Water Resources is as shown Figure 4.2:

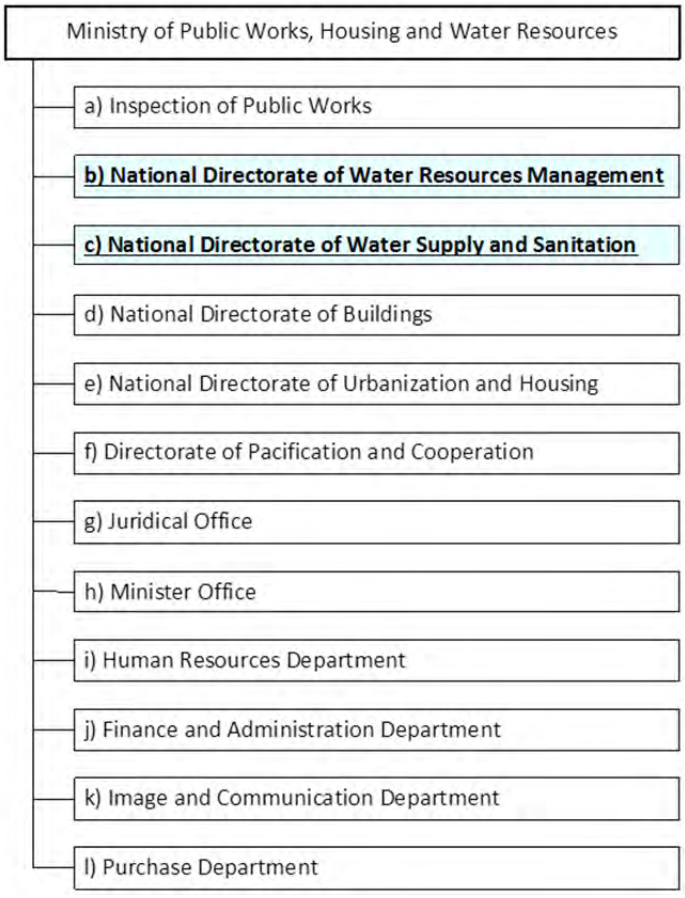


Figure 4.2 New structure of the Ministry of Public Works, Housing and Water Resources

As seen in the above b) and c), the functions of the former DNA were transferred to the two new directorates, i.e. National Directorate of Water Resources Management and National Directorate of Water Supply and Sanitation. The National Directorate of Water Resources Management is responsible for water related disaster risk management as one of its tasks and is the main counterpart of this JICA assistance. The National Directorate of Water Resources Management has the following mandates according to the Resolution:

Table 4.3 Mandate of the National Directorate of Water Resources Management (DNGRH)

Mandate of the National Directorate of Water Resources Management (DNGRH)	
a)	Propose policies and strategies of development, conservation, appropriate use and exploitation of water resources of river basins;
b)	Ensure availability of water resources in quantity and quality for different uses;
c)	Coordinate cooperation actions in the domain of shared water resources, ensuring the participation of the cooperative organizations in water control;
d)	Assess the achievement of international agreements about the use of shared water resources;
e)	Periodically assess water resources of the river basins and the water needs at national and regional levels;
f)	Establish a cadaster of the use and exploitation and operate in national information system about water resources;
g)	Elaborate and monitoring the implementation of the river basin plans to support at short, middle and long term, the use and exploitation, conservation and development of water resources following the principle of unity and consistency of the management of river basin;
h)	Promote investments for the construction and maintenance of a strategic exploitation for management, storage, protection, transportation of water, as well as the regulation of the river mouth, ensuring its sustainable use;
i)	Realize strategic studies for conservation, protection and development of water resources;
J)	Elaborate legislative proposal and regulation about water resources and ensure its inspection and accomplishment;
k)	Maintain updated cadaster with aim to ensure the conservation of the heritage of the public water domain;
l)	Ensure the integrated and rational management of the water resources of the administration system of water resources, in the base of the river basins;
m)	Ensure the strategic planning for the management of the water resources;
n)	Ensure the establishment of the flood forecasting and early warning system;
o)	Elaborate, update and monitoring the implementation of the national plan for the construction of hydraulic infrastructure;
p)	Promote investments for the construction, maintenance and expansion of infrastructure for management, protection and storage of water;
q)	Propose definition of the risk area prone to floods and droughts;
r)	Realize other activities which are superiorly determined in the terms of the present Statute and by the applicable low.

Organizational structure of the National Directorate of Water Resources Management is as indicated in Figure 4.3.

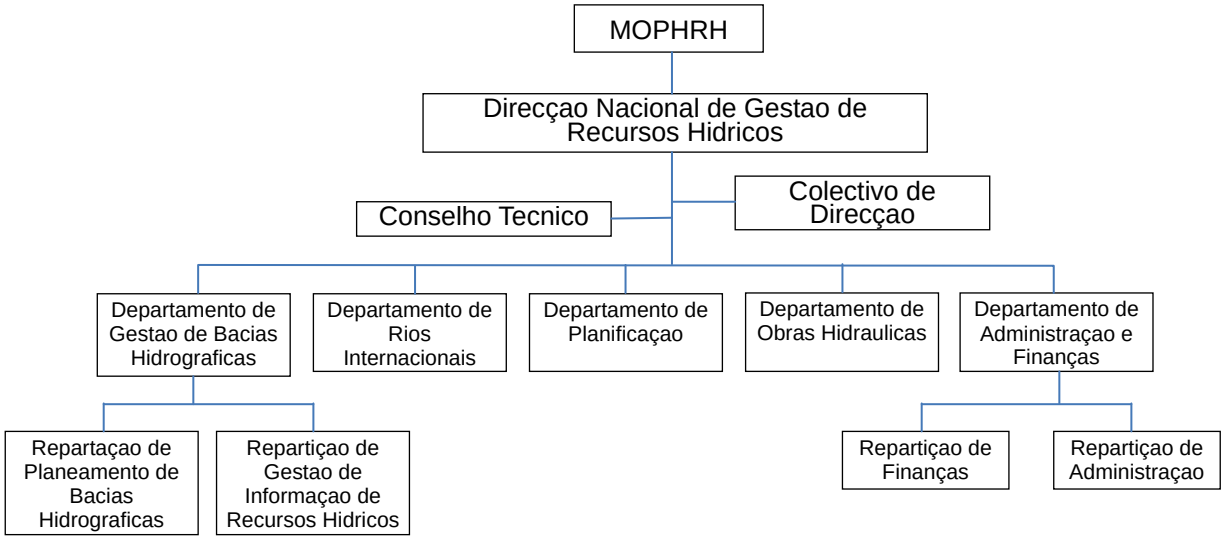


Figure 4.3 Organizational Structure of the National Directorate of Water Resources Management

(2) Advise of JICA Team for Organizational Plan

- From the technical viewpoint, a river management authority like DNGRH should have three major functions, i.e. 1) strategic planning, 2) implementation of the planned measures, and 3) operation and maintenance (O&M).
- Strategic planning is very important role for river management authority. DNGRH should have strategic plan for the river basins to flow flood water safely in coordination with all development sectors such as structural development, bridge construction, irrigation development, etc.
- In Mozambique, operation and maintenance of the river facilities are mandate of ARAs. However DNGRH should have a department in charge of O&M at national level that formulates policy and strategies of O&M and oversees all the O&M activities of ARAs.
- Monitoring of hydrological data, data compiling and archiving, management of the river space, management of the water use lights, approval of water usage are also the important tasks of the department of O&M. The department of O&M should be separated from the department of implementation, because it should have a strong administrative power to oversee and control utilization of water, river space, etc. Water use administration and river space administration are very important function of the department of O&M.
- The task of the Division of Human Resources should be specialized in technical training and capacity development of human resources. Administrative works relating to human

resources such as contracting, recruitment, retirement, salary adjustment, etc. should be implemented by other administrative division.

- It was a good development that the River Basin Management Department was newly established.

5 Overall Recommendations and Action Plan

Chapter 2, 3 and 4 present recommendations regarding water related disaster management, formulation of water related disaster management plan and human resources and institutional development. This chapter clarifies issues/problems at the beginning of the Assistance, activities in the Assistance, improved/obtained knowledge and skills, and next actions. And then it illustrates Action Plan for implementation of next actions.

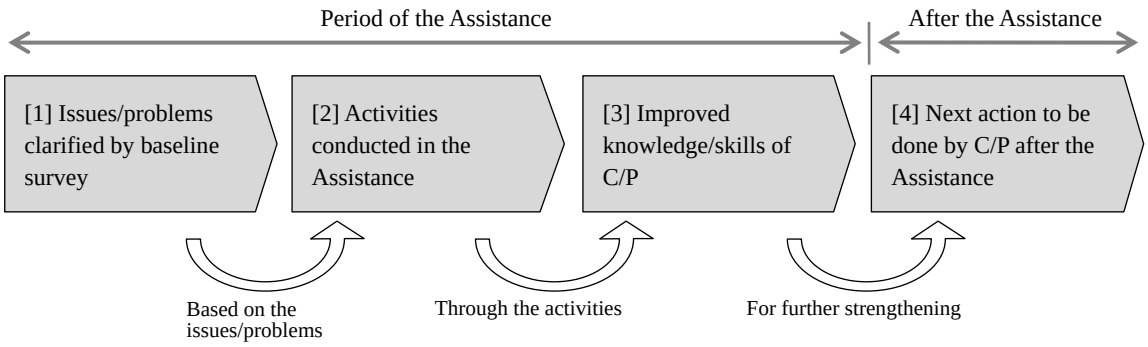
5.1 Issues/Problems, Activities, Improved/Obtained Knowledge and Skills, and Next Actions

Activities conducted in the Assistance are mainly divided into the following 7 fields.

A. Hydrological observation/ Hydrological data
B. Characteristics of river / river basin
C. Structural measures
D. Flood early warning system (non-structural measure)
E. Easily understandable disaster information (non-structural measure)
F. Inventory of river management structures
G. Human resource and institutional development

At the beginning, we conducted baseline survey trough work shop and interview in order to grasp the issues/problems regarding flood risk management. And then we designed and conducted a variety of activities based on the defined issues/problems. Through these activities C/P improved/obtained their knowledge and skills about flood risk management. However, it remains for C/P to further strengthen even after completion of the Assistance. Finally, JICA Team made recommendations as next actions to be done by C/P after the Assistance.

Table 5.1 describes the above issues/problems [1], conducted activities [2], improved knowledges/skills [3] and next action [4] for each field from A to G.



5.2 Action Plan

JICA Team prepared the Action Plan for implementation of the above next actions in consideration of the priority and needed period as shown in Figure 5.1. Action Plan is scheduled from 2018 until 2030, which is the target year of Sendai Framework for DRR.

Table 5.1 Issues/problems – Conducted Activities – Improved Knowledge and Skills – Next Steps

[1] Issues/problems identified through the baseline survey, etc. at the beginning of the Assistance	[2] Activities regarding the issues/problems conducted in the Assistance	[3] Improved/obtained knowledge or skills of C/P through the activities	[4] Next steps after the Assistance
A. Hydrological observation/data			
・ Hydrological data in database is not updated for last several years. ・ Some hydrological databases are used due to storage capacity. ・ There is no budget to renew the license of the database or to rebuild a database with latest OS.	・ To make a list of hydrological data in database and clarify hydrological station with data availability ・ To prepare location map of hydrological station	・ To clarify data availability by stations ・ To understand the problem of data (Ex break in continuity of data, unbalanced distribution of stations, delay of recent data input, etc.)	・ To establish an integrated hydrological Database in consideration of license renewal ・ To integrate the data stored in several data bases into the new database ・ To share the data managed by other organization (INAM, MINAG, etc.) integrating the data
・ The observer uses mismatched rainfall measuring glass for a collector of rainfall gauge	・ JICA Team informed the findings at the seminar. ・ DNGRH instructed ARAs to survey.	・ To learn that inaccurate data is accumulated by using unsuitable apparatus or measuring method	・ To survey the way of hydrological observation and apparatus for all stations
・ Rainfall stations are few compared with river basins' scale. ・ Rainfall stations which can provide the observed data immediately during flood are limited.	・ To held seminars/workshops regarding of satellite based data (GSMaP、GFAS、Flood Map、Dem, etc.)	・ To learn various free tools for utilizing satellite data and how to use these tools.	・ To frequently visit web-site of satellite based rainfall (Ex. GSMaP、GFAS, etc.) that can provide actual/predicted rainfall amount or probability and to promote understanding of it (rainfall distribution, moving of rainfall range, gap between the information and existing situation, etc.)
・ Reliability of data is low. - C/P don't believe in data observed by resident. - HQ curve has not been revised.	・ To introduce the hydrological observation guidebook, which is easily understandable and translated to Portuguese ・ To instruct easy cross-section measuring on site, which is needed to calculate discharge and how to make HQ curve based on hydraulic analysis	・ To understand the points of hydrological observation ・ To understand the necessity of HQ curve according to river cross-section for accuracy of discharge and regular cross-section survey for it ・ To conduct easy cross-section survey using pole and tape	・ To instruct importance and a way of hydrological observation to resident in charge ・ To do an overhaul of HQ curves for all stations ・ To regularly conduct cross-section survey ・ To check the gaps between observed water level/discharge and HQ curve and to evaluate the change of cross-section
・ Abnormal values occasionally appear in database.	・ To instruct that the importance of error check just after the observation and the way to check	・ To draw hyeto-hydrograph by hand in order to check the error	・ To become accustomed to error check just after the observation
B. Characteristics of river / river basin			
・ C/P don't understand river/river basin characteristics so well.	・ To hold the training on understanding the river/river basin characteristics using satellite image (Google Earth).	・ To know how to grasp the river/river basin characteristics using Google Earth, e.g. river longitudinal profile, river basin gradient, river meandering, rock riverbed, sand hill along shore, etc.	・ To deepen understanding river/river basin characteristics observing satellite image, topographic map or existing condition on site
・ Director General of ARA-CN requested C/P to learn how to calculate storage volume at a dam site.	・ To teach how to calculate storage volume using GIS and Excel.	・ To draw contour line and measure area by elevation on GIS ・ To estimate relation between elevation and storage volume	
C. Structural measures			
・ Work experience about planning of structural measures is insufficient.	・ To examine structural measures as a component of flood risk management plan	・ To understand the function of each structural measure and to propose appropriate structures according to expected function	・ To make effort to examine the structural measures for other river basin or other flood scale ・ To decide the structural measures based on the disaster reduction effect estimated by flood simulation, economic evaluation in the future
D. Flood early warning system			
・ People can't complete evacuation before the inundation occurs because they don't have enough time after they receive the flood warning.	・ To establish the flood early warning system (Atuto-IFAS) for Licungo River	・ To build IFAS/Auto-IFAS model and operate it ・ To predict water level based using the above model	・ To establish 24-hour operation system ・ To conduct hourly water level observation at Mocuba bridge ・ To review the timing of warning issue, alert water level, etc. based on the record during flood

[1] Issues/problems identified through the baseline survey, etc. at the beginning of the Assistance	[2] Activities regarding the issues/problems conducted in the Assistance	[3] Improved/obtained knowledge or skills of C/P through the activities	[4] Next steps after the Assistance
	・ To held training on “Hydrological & Hydraulic Trainer” and ”IFAS & Auto-IFAS Modeling Trainer”	・ To obtain skills of hydrology & hydraulics and modeling as a trainer	・ To conduct training on hydrology/hydraulics and river engineering for engineers of DNGRH and ARAs by Hydrological & Hydraulic Trainer/ IFAS & Auto-IFAS Modeling Trainer
	・ To examine flood response by Mocuba Unit under operation of flood early warning system	・ To implement appropriate flood response by Mocuba Unit e.g. transfer of observed data to DNGRH, judge issuing the warning based on the simulated result, issue of the warning to relevant organizations, etc. ・ To learn gaps between peaks of rainfall and water level, time gap of satellite based rainfall, etc.	・ To increase water level observation at Mocuba bridge, especially after 17:00 (hopefully hourly observation) ・ Not to overestimate the early warning system and to collect information and observe data during flood
E. Easily understandable disaster information			
・ People don’t understand the severity and urgency from issued warning message.	・ To examine existing disaster information issued by relevant organizations and introduce how to express the severity or urgency	・ To understand that disaster information must encourage people to take prompt and appropriate action ・ To make disaster information understandable with concise tile, comparison with past severe flood, concrete action to be taken	・ To review the expression and revise if necessary after flooding
・ Hyeto-Hydrograph in "Bulletin of National Hydrology" is unclear because it shows similar 3 water levels (one is water level in this year and others are those in past 2 years).	・ To recommend illustrating water levels of this year, last year and highest water level in the past.	・ To revise the graph in the bulletin and hydrological information monitor based on the recommendation.	
F. Inventory of river management structures			
・ River management structures are frequently damaged by flood due to insufficient maintenance work.	・ To inspect the river management facilities including hydrological stations and to give guidance on inventory of river management structures	・ To understand the function of each river management structure and damage causes ・ To recognize the importance of regular inspection and early repair in order to sustain their functions ・ To make inventory of river management structures linked base map on Google Earth	・ To continue preparing the inventory sheets and revise the contents if necessary ・ To decide the priority of repair works based on the inventory ・ To secure stable internet access for base map on Google Earth
G. Human resource and institutional development			
・ Tasks of flood management are divided into some departments e.g. department of water resources, international river basin, etc. in DNGRH.	・ JICA Team recommended creating an independent section in charge of flood risk management.	・ To establish new unit of flood & draught management	・ To recruit, conduct training, improve the quality and quantity of work in order to strengthen the institutional capacity of the new unit ・ To establish a department in charge of river maintenance in order to lead ARAs for river management, spatial control, water usage, etc.
・ DNGRH has annual training plan but it mainly focuses on water supply and sewerage not flood risk management.	・ To prepare the syllabuses regarding river administration , flood risk management and hydrology/hydraulics trainer	・ To secure the training syllabus to improve the capacity of flood risk management	・ To incorporate the training syllabus about water related disaster risk management into the annual training plan
・ All the trainings depend on support by donors.			・ To conduct the training proposed in the Assistance on the initiative of DNGRH

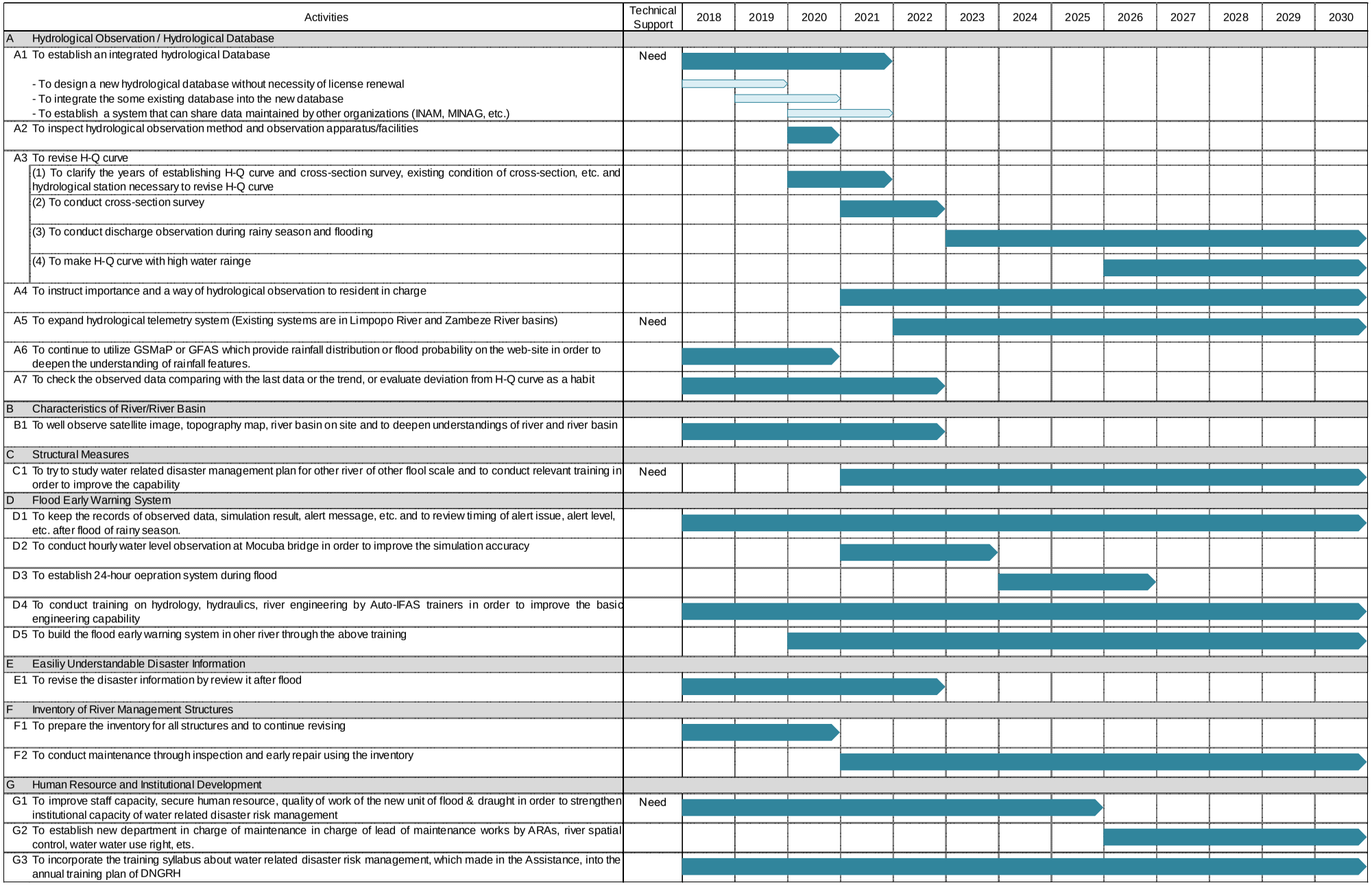


Figure 5.1 Action Plan