The Kingdom of Bhutan
Ministry of Economic Affairs

THE KINGDOM OF BHUTAN

THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

PROJECT COMPLETION REPORT

SEPTEMBER 2016

Japan International Cooperation Agency
(JICA)

Earth System Science Co. Ltd.

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Technical Cooperation Output (Separate Volume)

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Abbreviations

AWLS	Automatic Weather Level Station
AWS	Automatic Weather Station
BICMA	Bhutan InfoComm and Media Authority
CBDRM	Community Based Disaster Risk Management
COS	Central Operation System
C/P	Counterpart
CR	Control Room
DCP	Data Collection Platform
DDM	Department of Disaster Management
DDMO	Dzongkhag Disaster Management Office
DGM	Department of Geology and Mines
DHMS	Department of Hydro-met Services
DHS	Department of Human Settlement
DoES	Department of Engineering Service
DoSE	Department of School Education
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EOC	Emergency Operation Center
EWS	Early Warning System
FEMD	Flood Engineering Management Division, DoES
FHM	Flood Hazard Map
FMCR	Flood Monitoring and Command Room
FMI	Finnish Meteorological Institute
GIS	Geographic Information System
GNHC	Gross National Happiness Commission
GPV	Grid Point Value
GTS	Global Telecommunication System
GLOF	Glacial Lake Outburst Flood
ICT	Information Communication Technology
IMD	India Meteorological Department
IMTF	Inter-Ministerial Task Force
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
MDRR	Mainstreaming Disaster Risk Reduction
MHPA	Mangdechhu Hydropower Authority
MSS	Message Switching System
NDMA	National Disaster Management Authority
NLCS	National Land Commission Secretariat
NOAA	National Oceanic and Atmospheric Administration
NWFWC	National Weather and Flood Warning Center
NWP	Numerical Weather Prediction
OJT	On the Job Training
PC/R	Project Completion Report
PDM	Project Design Matrix
PO	Plan of Operation
SATAID	Satellite Animation and Interactive Diagnosis
SOP	Standard Operating Procedure
TMD	Thai Meteorological Department
UNDP	United Nations Development Programme
WB	World Bank
W/G	Working Group
WIS	WMO Information System
WMO	World Meteorological Organization

Chapter 1 Introduction

1.1 General

Bhutan is experiencing an increase in the number of disasters related to hydro-meteorological hazards. For instance, a record rainfall in May 2009 brought by Cyclone Aila left 12 people dead and damages to the infrastructure, which cost US$ 15.8 million. On the other hand, risk of glacial lake outburst flood (GLOF) increases because of global warming. Since the 1960s, a number of GLOFs have been recorded concurrently with the shrinkage of glaciers and expansion of glacial lakes over the region. The most recent GLOF occurred in October 1994 from the partial burst of the Luggye Tho in eastern Lunana. This flood caused loss of 21 lives and extensive damage to property along the Punakha - Wangdue valley. Therefore, continuous monitoring and installing an early warning system for rainstorm flood and GLOF were recommended by a previous study. Considering such situations, the Department of Hydro-met Service (DHMS), Ministry of Economic Affairs (MoEA), Royal Government of Bhutan tried to cope with such a situation. However, the capacity of monitoring and flood warning was limited. Thus, the Royal Government of Bhutan requested the Government of Japan for a technical cooperation project. As the result, “The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning” was launched in September 2013.

The Project focuses on capacity development of central and local governments for weather and flood forecasting and early warning and emergency response against GLOF and rainstorm flood in the Mangdechhu and Chamkharchhu river basins. The Project also contributes to mainstreaming disaster risk reduction (MDRR) into development plans. As a result, a nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation will be realized in Bhutan. The Project was implemented for three years from September 2013 to September 2016. This Project Completion Report compiles all the Project achievements for three years.

1.2 Project Area

The Project areas, Thimphu and the Pilot Project Areas (Mangdechhu and Chamkharchhu river basins) are shown in Figure 1.1

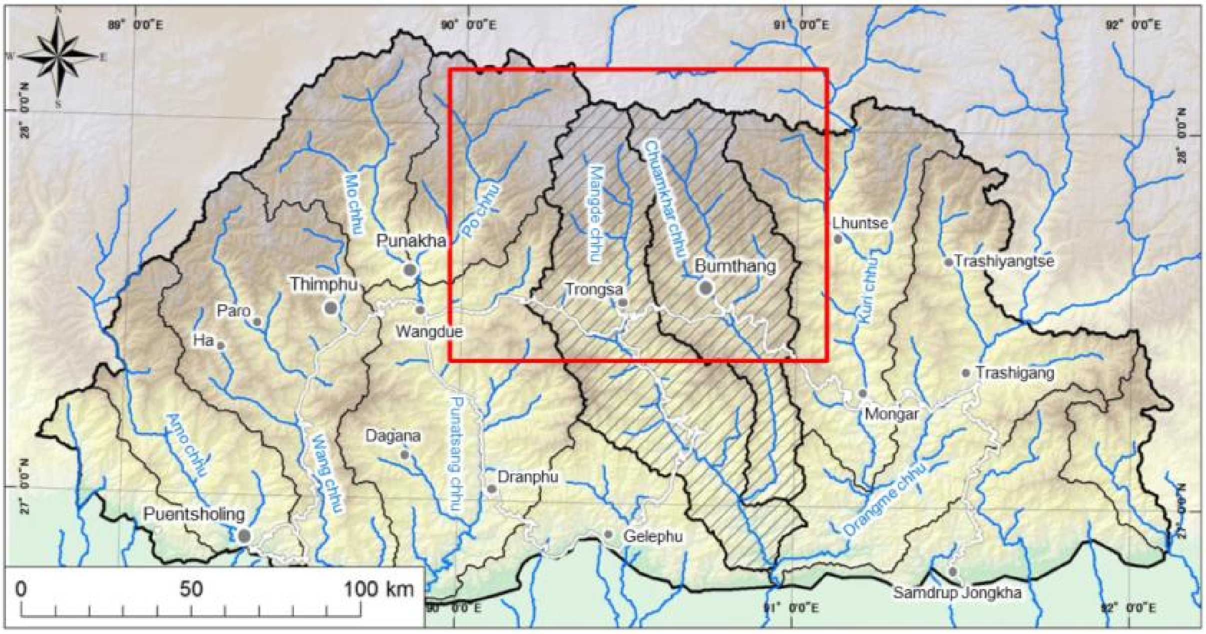

Figure 1.1 Project Area

1.3 Target Beneficiary Population

The target number of beneficiary population for capacity development through the Project implementation is shown in Table 1.1

Table 1.1 Target Beneficiary Population for Capacity Development

	Agency	Department	Number	Remarks
Direct Beneficiary	DHMS	Director	1	1) C/P for daily project activities 2) Supporting staff for the installation of Global Telecommunication System (GTS) and Early Warning System (EWS) and 3) Trainees for C/P trainings in Japan
		Hydrology	12	
		Meteorology	11	
		Snow & Glacier	1	
		Planning, Coordination & Research	4	
		District office	4	
		Total	33	
	DDM		3	1) Participants of baseline survey 2) Members of flood hazard map and mainstreaming disaster risk reduction working groups and 3) Trainees for C/P trainings in Japan
	DGM		1	
	DoES		7	
	NLCS		3	
	DHS		2	
		Total	16	
	Trongsa District	District	14	1) Seminar and/or workshop participants (district, county, target communities and schools) 2) Target people for evacuation based on EWS warning sirens 3) MHPA Staff related to EWS installation and 4) Trainees for C/P trainings in Japan
		County	1	
		Community (& School)	51	
	Bumthang District	District	16	
		County	2	
		Community (& School)	2,094	
	MHPA	MHPA	5	
		Total	2,183	
		Total	**2,232**	
Indirect Beneficiary	Trongsa District		150	
	Bumthang District		2,800	
	MHPA	MHPA	500	
		Contractor	6,000	
		Total	**9,450**	

Chapter 2 Methodology of Project Implementation

2.1 Project Purpose, Outputs and Activities

The Project was implemented based on the Project Design Matrix (PDM) and the Plan of Operation (PO) attached in the Record of Discussions agreed and signed on May 14, 2013 (refer to Appendix 2). The Project Purpose, Outputs and Activities described in the PDM are as follows:

Overall Goal: Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.

Project Purpose: Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.

Output 1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.

Activities

1-1 Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.

1-2 Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.

1-3 Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.

1-4 Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector.

1-5 Prepare and improve GLOF/rainstorm flood risk zonation to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLCS staff.

1-6 Foster the sense of land use management among related agencies through workshops, etc.

1-7 Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans.

1-8 Improve flood and weather forecasting system by use of accumulated hydro- meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).

1-9 Develop SOP on emergency information sharing through discussion and workshops with relevant agencies.

Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.

Activities

2-1 Review existing hydro-meteorological network and planned hydropower plants from the view point of administrative response on GLOF/rainstorm flood.

2-2 Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing the EWS.

2-3 Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.

2-4 Install equipment and facilities for the EWS in both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.

2-5 Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.

Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.

Activities:

3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.

3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-5, 2-2.

3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.

3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.

2.2 Implementation Structure

The Project was implemented by the following structure as shown in Figure 2.1.

- Main counterpart agency: DHMS (Project Director: Director of DHMS, Project Manager: Chief of Hydrology Division, DHMS)
- Sub counterpart agency: Department of Disaster Management (DDM), Department of Geology and Mines (DGM), Department of Engineering Services (DoES), National Land Commission Secretariat (NLCS), Department of Human Settlement (DHS) and other relevant agencies

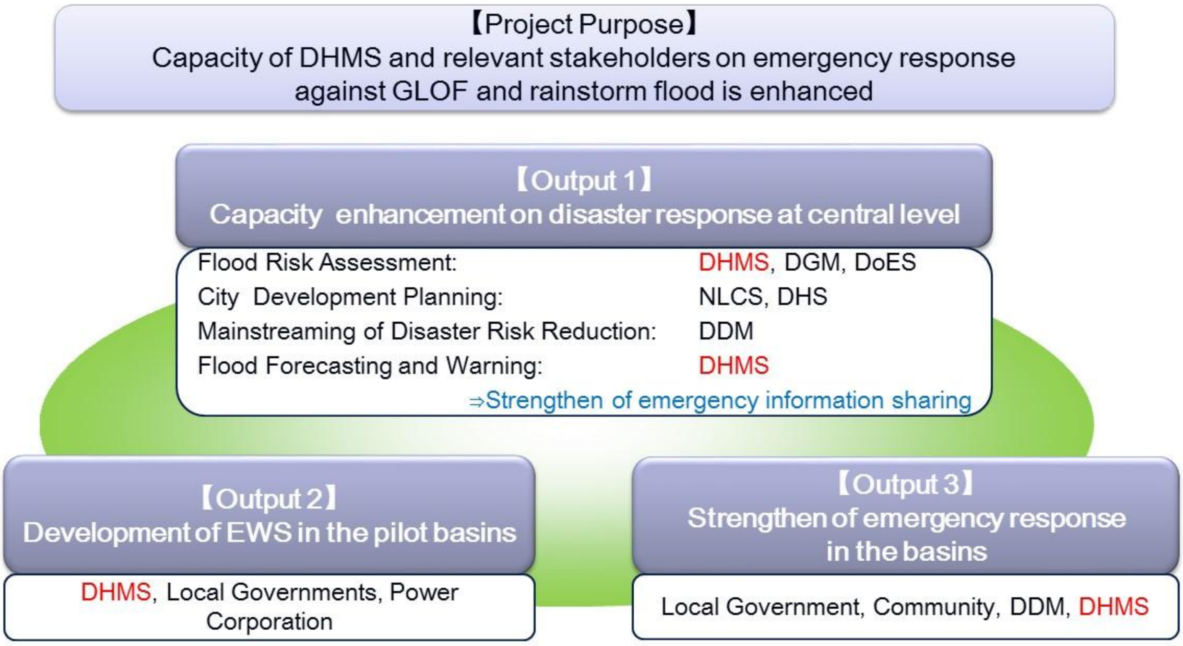

Figure 2.1 Project Implementation Structure

2.3 Implementation Schedule

Implementation phase and flow of the Project activities are shown in Figure 2.2. Detailed and specific project implementation schedule (plan and actual) prepared based on the PDM and PO is shown in Figure 2.3.

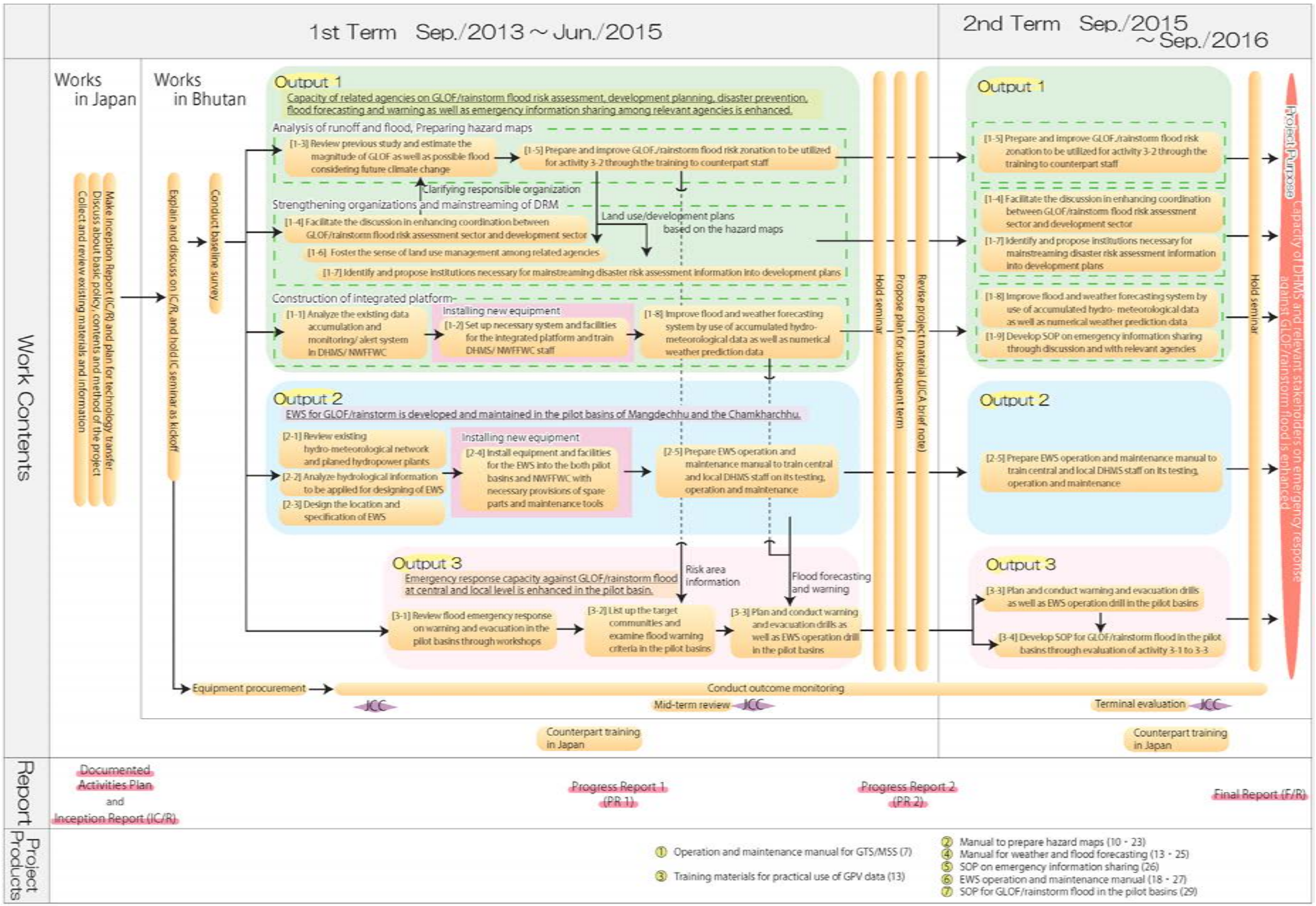

Figure 2.2 Work Flow

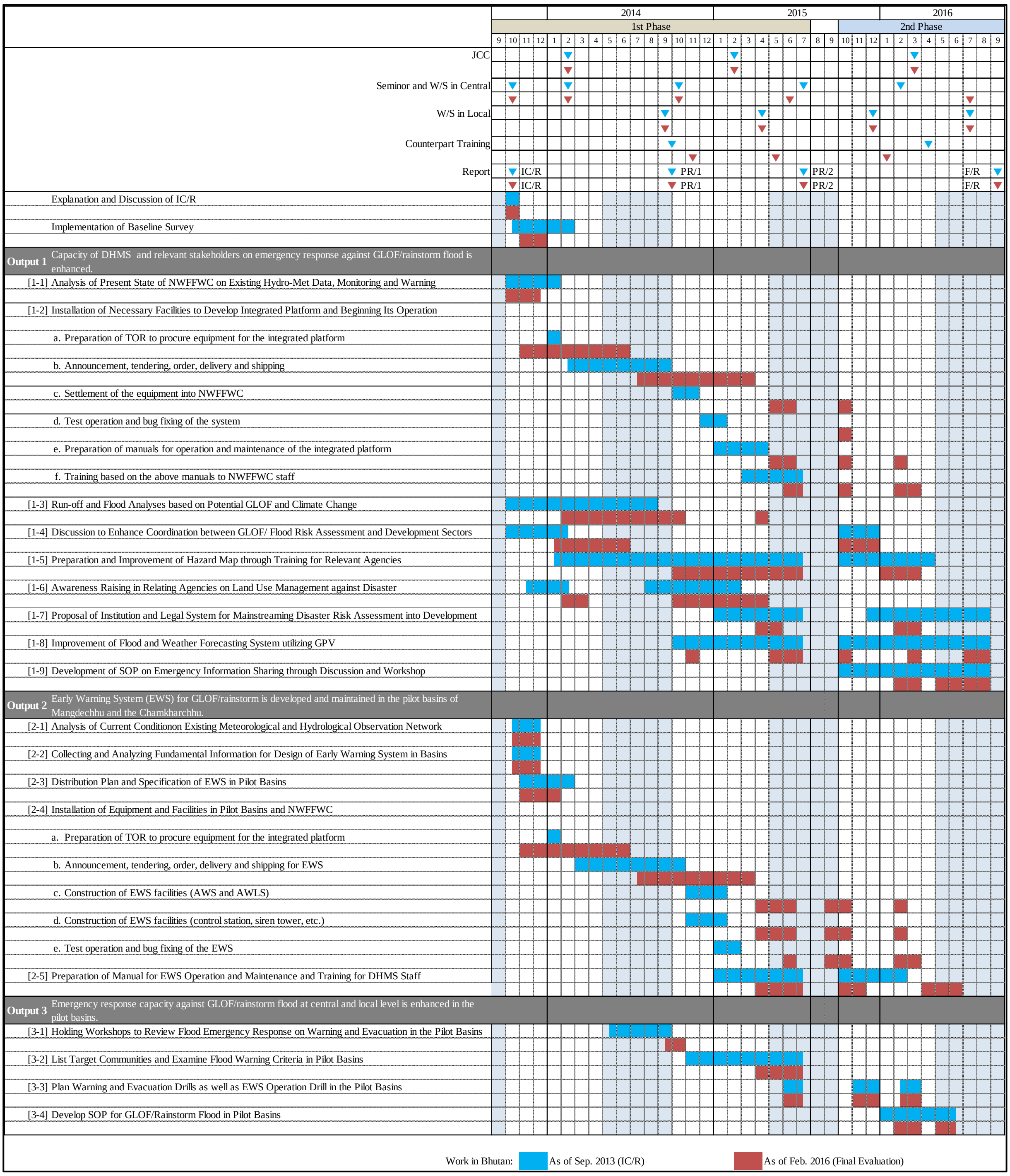

Figure 2.3 Project Implementation Schedule (Plan and Actual)

2.4 Input

2.4.1 Japanese Side Input

1) Dispatch of JICA Experts

The dispatch record of JICA Experts is shown in Figure 2.4. Nine (9) experts were dispatched with 87.90 M/M in total.

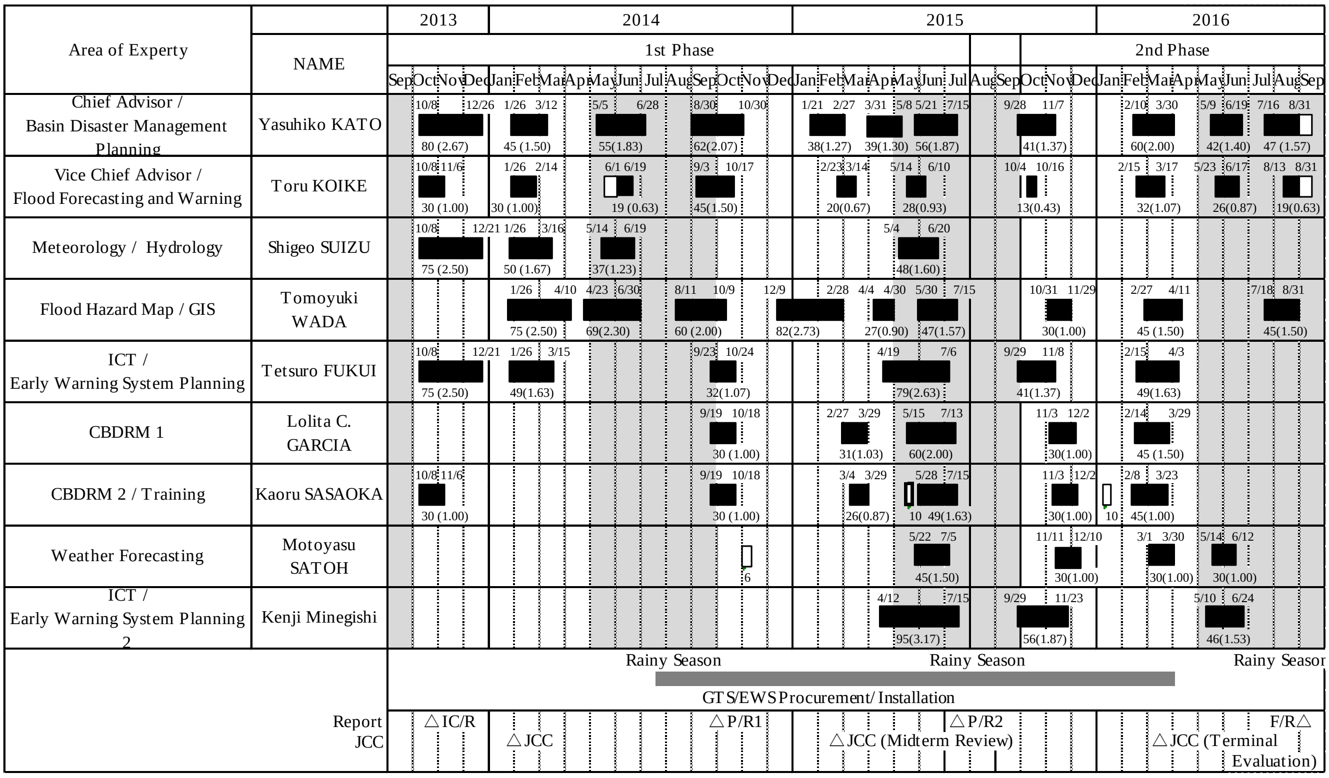

Figure 2.4 Expert Assignment Schedule

2) Counterpart Training in Japan

Eleven C/P Training in Japan (3 project custom-made and 8 JICA ready-made courses) were conducted during the Project period.

3) Equipment Provided

The procurement and installation works of the following equipment provided were conducted by the JICA Contractor (Helicom Corporation Inc.) from July 2014 to March 2016.

- NWFWC : Global Telecommunication System (GTS)/ Message Switching System (MSS), operation system, manual and OJT
- Pilot Project Area (Mangdechhu and Chamkharchhu Basins): GLOF/rainstorm Early Warning System (EWS) including Automatic Weather Station (AWS), Automatic Water Level Station (AWLS), control room, flood warning siren, communication system, operation system, manual and OJT

The procurement and installation work of HimawariCast Receiving System at NWFWC were conducted by the JICA Expert Team in March 2016.

2.4.2 Bhutanese Side Input

1) Assignment of Counterpart Personnel

The main counterpart agency, DHMS and five sub-counterpart agencies, DDM, DGM, DoES, NLCS and DHS assigned appropriate counterpart personnel (C/P) to implement the Project activity with JICA Experts. The counterpart list is shown in Appendix 3.

What is notable is that DHMS dispatched a total of 16 staff to the Pilot Project Areas for around 6 months (May to June and September to October 2015, February to March 2016), at its own expense to assist the EWS installation work by JICA Contractor with the cooperation of the JICA Expert Team.

2) Provision of Working Space

DHMS provided several working spaces with Internet access in the DHMS office to JICA Experts aiming at effective collaboration with the C/Ps and transfer of technology on a daily one-to-one basis.

3) Budget Allocation

DHMS and sub-counterpart agencies secured and disbursed the following co-financing budget to implement the Project activities not covered by JICA.

- C/P personnel cost
- DHMS, DDM and DoES travel allowance to the Pilot Project Areas

4) Land Acquisition and Cutting Trees

DHMS completed the land acquisition (in coordination with district land acquisition committee and NLCS) and obtained the permission for cutting trees (in coordination with the Department of Forests and Park Services, MoAF) for the installation sites of EWS facilities (1 AWS, 3 AWLS and 7 flood warning sirens) before the commencement of the installation work.

Chapter 3 The 1st Phase Achievements (Sep. 2013 - Jul. 2015)

This chapter compiles all the achievement of the Project activities in the 1st Phase (September 2013 – July 2015). The contents of this chapter is prepared by incorporating and re-editing the Progress Report 1 (September 2014) and Progress Report 2 (July 2015) of the Project.

3.1 Achievements Related to Entire Project

All the Project achievements related to entire project in the 1st Phase (September 2013 - July 2015) are described in this section.

3.1.1 Discussion with Bhutanese Side

1) Inception Report Meeting

(1) DHMS

The Project Inception Report meeting was held at DHMS on October 17, 2013 as the Project kick-off. The main counterpart agency DHMS, Sub-counterpart agencies DDM, DGM, DoES, NLCS and GNHC attended the meeting. It was agreed that DHS would participate in the Project as a Sub-counterpart agency to promote Mainstreaming Disaster Risk Reduction into the regional development plan. The meeting also discussed that the district governments in two pilot river basins be invited as Joint Coordinating Committee (JCC) members. The Minutes of the Meeting is as shown in Appendix 4. The meeting was widely covered on BBS, national TV and KUENSEL, the national newspaper.

(2) Trongsa District

An inception Report meeting was held at Trongsa District office on October 24, 2013. Around 20 participants attended the meeting such as deputy governor, district government staff from several sectors including disaster focal persons, the site manager of Mangdechhu Hydroelectric Project Authority (MHPA), county chief, community representatives and school principal.

It was agreed that the district official will join the Project as JCC member. DHMS requested the district government for support and assist for land allocation for setting up of EWS facilities and the district agreed with that.

(3) Bumthang District

An inception Report meeting was held at Bumthang District office on October 28, 2013. Around 20 participants attended the meeting such as school superintendents on behalf of deputy governor, district government staff from several sectors including disaster focal persons, Choekhor county chief, community representatives and school principal.

It was agreed that the district official will join the Project as JCC member. DHMS requested the district government for support and assist for land allocation for setting up of EWS facilities and the district agreed with that.

2) 1st Joint Coordinating Committee (JCC)

The 1st Project Joint Coordinating Committee (JCC) meeting was held at DHMS on February 7, 2014. The meeting was attended by officials from central government agencies in Thimphu and disaster focal persons from two districts. The Minutes of the Meeting is as shown in Appendix 5. The following are the main point discussed

- All the six counterpart agencies officially assigned appropriate counterpart personnel.
- All the participants agreed on the EWS system and its equipment/ facilities.
- Judging from the baseline survey results, it was agreed that the Project PDM was appropriate and it was not necessary to be revised at this stage.
- The project implementation schedule of each agency was agreed. (refer to Figure 2.3)
- Necessity of contact and follow up with BICMA on EWS communication frequency allocation
- Progress and status of land allocation formalities by DHMS for EWS facilities

3) Progress Report (1) Meeting

All the achievements and progress of the Project activities in the first half of the 1st Phase (September 2013 – September 2014) were compiled in the Progress Report (1) (P/R1) in September 2014. The P/R1 meeting was held at DHMS on July 16, 2014. The Minutes of the Meeting signed on September 30 is as shown in Appendix 6.

4) Progress Report (2) Meeting

All the achievements and progress of the Project activities in the second half of the 1st Phase (October 2014 – July 2015) were compiled in the Progress Report (2) (P/R2) in July 2015. The P/R2 meeting was held at DHMS on July 10, 2015. The Minutes of the Meeting signed on July 13 is as shown in Appendix 7.

3.1.2 Related Projects by Other Donors

1) UNDP

UNDP is supporting strengthening DHMS weather and hydrological networks (NAPA-II with USD 4 million). UNDP and the JICA Expert Team agreed to promote information sharing on both projects on October 11, 2013.

NAPA-I terminal evaluation mission visited the JICA Expert Team on December 12, 2013. The JICA Expert Team provided necessary Project information for information sharing.

After that, the JICA Expert Team conducted information sharing with UNDP periodically such as in the Mid-Team Review of the Project in February 2015.

2) World Bank

The JICA Expert Team discussed with the World Bank their proposed project for DHMS on October 20, 2013. The contents of the proposed project will be a socioeconomic study on Amochhu and Manas river basins in southern Bhutan and the project has no activity duplication with the JICA Project. The estimated project cost will be approximately USD 250,000.

The World Bank, DHMS, JICA Bhutan office and JICA Expert Team held a follow-up meeting on the proposed project on February 5, 2014. It was confirmed that the project formation status was almost the same as that in October 2013.

After that, the JICA Expert Team conducted information sharing with the World Bank periodically such as in the Mid-Team Review of the Project in February 2015.

3) Finnish Meteorological Institute

The Finish Meteorological Institute (FMI) is implementing the following project with Meteorological Division, DHMS. The project mainly deals with socio-economic aspects of weather forecasting and the major activity is short term counterpart training in Finland. FMI and the JICA Expert Team confirmed that there is no activity duplication between the two projects and agreed to exchange information on the progress of both projects.

- Name: Strengthening Hydro-Meteorological Services for Bhutan
- Period: May 2013 - May 2016
- Objective: To improve the capacity of DHMS to manage and produce high quality weather information and services
- Output: 1) Strategic planning capacity of DHMS strengthened, 2) Enhanced services provided by DHMS and 3) Improved DHMS cooperation and communication with the public, disaster management, media and renewable energy

3.1.3 Baseline Survey

A baseline survey aiming at understanding basic status and issues on all the counterpart agencies was conducted with DHMS C/P in November and December 2013 based on the interview and questionnaire /surveys to DHMS, DDM, DGM, DoES, NLCS and DHS. The survey result was finalized through the discussion in the workshops of the Mainstreaming Disaster Risk Reduction working group described in Section 4.4.

As shown in the baseline survey results as of December 2013 in Table 3.1 and Table 3.2, many Project activities can work as “Catalyst” (or Trigger) to solve the Issues & challenges of each C/P agencies. Judging from the baseline survey results, it was judged that the Project PDM was appropriate and it was not necessary to revise it at this stage.

Table 3.1 Summary of Baseline Survey by Agencies

		Department of Hydro-Met Services (DHMS), Ministry of Economic Affairs	Department of Disaster Management (DDM), Ministry of Home and Cultural Affairs	Department of Geology and Mines (DGM), Ministry of Economic Affairs	Department of Engineering Services (DoES), Ministry of Works and Human Settlements	National Land Commission Secretariat (NLCS)	Department of Human Settlement (DHS), Ministry of Works and Human Settlements
Year of Establishment		2011	2008	1981	2012	2007	2011
Name of Division (Number of Staff)		Planning, Coordination & Research (8) Hydrology (17) Meteorology (16) Snow & Glacier (5)	Preparedness & Mitigation (6) Response and Early Warning (7) Relief and Reconstruction (3)	Geology (30) *Glaciology (6) Mining (80) Seismology (4) (*:related to GLOF risk assessment)	Engineering Services (15) Engineering Adaptation and Risk Reduction (6) *Flood Engineering Management (FEMD) (8) Water and Sanitation (8) Rural Infrastructure (5) (*:related to flood risk assessment)	*Cadastral Information (44) Urban Land (6) Rural Land (52) Topographical Survey (28) Map Production (26) (*:related to property information on flood plain)	Urban Planning & Development (UPDD) (11) *Regional & Rural Planning (RRPD) (9) Compliance and Development Review (7) Survey & GIS (17) (*: related to regional development inclu. Bumthang)
Number of Total Staff		148	25	148	41	225	51
Future Reorganization Plan		nil	nil	nil	2 sections in FEMD in future	o (divided into 3 departments)	nil
Annual budget (2013 - 2014) (million Nu.)		92.462	20.560	70.000 (30% for risk assessment)	719.301 (*FEMD 55.000)	331.050	73.300 (*RRPD 24.500)
Roles and Responsibilities	Mainstreaming of disaster risk assessment	nil	Based on Disaster Management Act 2013, ensure that agencies mainstream disaster risk reduction into their development plans, policies, programmes and projects.	nil	nil	nil	･DHS uses any information and maps on risk assessment into development plan (such as Bumthang Master Plan 2013). ･However, staff in charge could access risk information personally by chance. ･DHS tries to disseminate risk information to public.
	Hazard map preparation	nil	Based on DM Act 2013, facilitate the formulation of hazard zonation and vulnerability	DGM prepared the GLOF hazard zonation along Punakha-Wangdi and Chamkhar Valleys in 2007	FEMD is mandated to carry out flood risk analysis in all 20 Dzongkhags. (However, it is	nil	S&GISD prepares geotechnical report (multi hazard map)

		Department of Hydro-Met Services (DHMS), Ministry of Economic Affairs	Department of Disaster Management (DDM), Ministry of Home and Cultural Affairs	Department of Geology and Mines (DGM), Ministry of Economic Affairs	Department of Engineering Services (DoES), Ministry of Works and Human Settlements	National Land Commission Secretariat (NLCS)	Department of Human Settlement (DHS), Ministry of Works and Human Settlements
			map by relevant agencies.	- 2008. (based not on hydrological/ hydraulic analysis.)	not clear which agency will prepare hazard maps.)		
	Information sharing	・GLOF: DDM and Dzongkhag, etc. based on SOP ・Flood: DDM and Dzongkhag ・Hydro-met data: relating agencies based on request, medias daily, hydropower project & India CWC hourly basis during summer	・DDM developed Disaster Management Information System (DMIS) as database and trained all Dzongkhag focal persons. ・DDM drafted Emergency Communication Network for functioning Emergency Operation Centre.	Reports and maps in DGM library are accessible to general public.	nil	Share maps and information on need basis	DHS share geotechnical report with other agencies.
Coordination and demarcation with Relevant Agencies (especially on flood risk)	DHMS		Receipt of weather forecasting & warning information during flood	Installation of GLOF EWS in Punakha-Wangdi Valley	Receipt of hydro-met information	Land allocation for observatory facilities	Receipt of hydro-met information
	DDM	Provision of weather forecasting & warning information during flood		Provision of technical expertise on flood (GLOF) hazard mapping and joint awareness campaign	All structural measures will be planned/ designed by FEMD, while all activities during disaster will be done by DDM.	nil	Share geotechnical report of human settlement.
	DGM	Installation of GLOF EWS in Punakha-Wangdi Valley	In Punakha-Wangdi Valley, GLOF hazard mapping by DGM, EWS installation by DHMS and joint awareness campaign and flow of information system by DDM		Receipt of geological and geotechnical information in DGM archives	Provision of base map and aerial photo for geoscientific studies	nil
	DoES	Provision of hydro-met information	(Still UNDP concept stage) The flood risk assessment at Dagana and Zhemgang Dzongkhags by	Provision of geological and geotechnical information in DGM archives		nil	Receipt of flood risk analysis studies for human settlement

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			FEMD and awareness raising activity				
	NLCS	Land allocation for observatory facilities	DDM is member of CGISC (Center for GIS coordination)	Receipt of base map and aerial photo for geoscientific studies	Receipt of Digital Elevation Model for GIS based studies		*Demarcation of land is carried out jointly by both surveyors after detailed plan formulated. *DHS is a member of CGISC
	DHS	Provision of hydro-met information	Share geotechnical report of human settlement.	nil	Provision of flood risk analysis studies for human settlement	Demarcation of land is carried out jointly by both surveyors after DHS formulated plan.	
Coordination and demarcation with Dzongkhag Administration		Provision of hydro-met (and GLOF to some district) information based on request ・Land acquisition for hydro-met stations	Provision of training to Dzongkhag disaster focal persons	Some coordination during risk assessment studies	All flood prevention structures in Dzongkhag are planned/designed by FEMD. The construction are implemented by Dzongkhag.	Coordination based on Land Act 2007	・DHS prepares all human settlement plans with various assistance from Dzongkhag. ・DHS provides technical expertise in planning process.
Issues/ challenges to be solved	Institutional and social level	・No services policy ・No institute to carry out training in Bhutan ・Need to enhance public awareness activities ・Need to establish proper communication with DDM, Dzongkhag and media during flood	・Prompt enactment of the rules and regulation of DM Act 2013 ・Prompt establishment of Inter-Ministerial Task Force and Disaster management units in Ministries/Agencies	・Low public awareness on importance of disaster risk reduction and mitigation activities ・Lack of quality data for research and investigation	・Unavailability of data for risk analysis such as hydro-met data, Digital Elevation Models, geotechnical data ・No private firms capable of outsourcing flood risk assessment in Bhutan	Need to end de-fact and illegal ownership of land	・Difficulties in the coordination between DHS’s flood/landslide hazard zonation and DGM’s GLOF hazard zonation in Bumthang ・No official route to access risk assessment information ・No common platform or forum for sharing information from where information can be obtained smoothly without many formalities ・Public response to

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							demarcation of disaster risk areas as no construction development is very poor.
	Organization level	・Develop reliable EWS system ・Placement not commensurate with cross sectoral responsibilities ・Ratio of hydro-met professional to technician is not appropriate	Insufficient technical and managerial capacity	・Limited human resources and financial capacity ・No or limited instrumentation ・Low priority in research activities	Need to recruit and train more professional staff as FEMD is at infancy stage	Requires further decentralization	A systematic checklist and a planning guide need to be prepared to assist planners
	Personal level	・Require more expertise in weather, climate and water resources field ・Limited technical capacity	No professional Dzongkhag disaster focal person assigned exclusively for disaster management	Limited interaction and exchange of ideas due to fewer numbers of national professionals involved in disaster risk assessment	nil	Requires capacity building	Planners need to be trained and exposed to mainstreaming issue

Table 3.2 Summary of Baseline Survey by Subjects

	Subject		Institutional and Social System Level	Organizational Level	Personal Level
1	Mainstreaming of Disaster Risk Reduction into Development	Issues/challenges to be solved	・Advocacy on DM Act 2013 to districts/sectors in order to create awareness on the requirement of mainstreaming DRR into their plans, policies and program has not been carried out. ・DM Rules and regulation is still in draft ・Organizational priority over DRR activities is not so high. ・Institutions to promote the mainstreaming such as Inter-Ministerial Task Force based on Disaster Management Act 2013 has not yet been established. ・As of today, there is no clear institutional mandates on disaster risk reduction; there seems to be some duplication	・So far, no specific policies and budget in related agencies for this purpose ・Limited coordination and systematic communication between agencies on this issue	Lack of awareness so far
		Conceivable solutions	・Prompt adoption and enforcement of the rules and regulation of DM Act 2013 and educate the public on it.・Prompt establishment of the institutions based on DM Act 2013・As per DM Act 2013, DDM ensures and coordinates agencies to mainstream disaster risk reduction into their development plans, policies, programmes and projects.・Identify and propose institutions necessary for the mainstreaming (Activity 1-7)	・Discussion & formal communication between risk assessment sector and development sector to enhance coordination (Activity 1-4)・Workshops for awareness raising in related agencies on land use management against disaster (Activity 1-6)	Awareness raising on the mainstreaming through media, seminar, workshops, working groups etc. (Activity 1-4, 1-6 and 1-7)

	Subject		**Institutional and Social System Level**	**Organizational Level**	**Personal Level**
2	Hazard Map	Issues/challenges to be solved	・No clear-cut coordination mechanism among technical agencies for development of hazard maps・Inter-Ministerial Task Force to look into this kind of technical work is not formed yet. ・There is a strong need to identify specific agency to be able to prepare hazard map when other agencies required.・No official route to access risk assessment information・No common platform or forum for sharing risk and hazard information from where information can be obtained smoothly without lengthy formalities	DHMS: No professional staff in this field and no activity so far but provides required data to other agenciesDDM: Lacks GIS technical know-how skillsDGM: GLOF hazard zonation along Punakha-Wangdi and Chamkhar Valleys in 2007 - 2008 were not based on hydrological/ hydraulic analysis.DoES: FEMD is mandated to carry out flood risk analysis in all 20 Dzongkhags, however needs to recruit and train more professional staff as FEMD is in infant stage.DHS: DHS is not mandated to carry out hazard mapping. However DHS carried out multi-hazard mapping required to prepare master plan for urban area development by outsourcing because required hazard maps were not available with other government agencies.	Need more training on the preparation methodology to develop more professional staff in this field
		Conceivable solutions	・DDM to facilitate coordination with relevant agencies on this issue to make the demarcation and mandates clear to avoid the duplication and miss match of hazard maps in the same area like in Bumthang.・Formation of Inter-Ministerial Task Force that can look into technical matters	・Update/prepare the maps by conducting hydrological/ hydraulic risk analysis for Mangdechhu and Chamkharchhu basins (Activity 1-3) (The case should be for all up-coming risk analysis)・Build capacity of DHMS and collaborating agencies in flood hazard mapping through trainings and counterparts apprenticeship. (Activity 1-5)	Provision of training on the map preparation process to the staff of related agencies (Activity 1-5)
3	Regional Disaster Management and Contingency Plan	Issues/challenges to be solved	・Establishment of the implementation structure of Dzongkhag Disaster Management Committee (DDMC) is still underway. ・Guideline for development of DM and Contingency plans is not finalized yet.	None of Dzongkhags have formulated the Plans so far.	・No professional Dzongkhag disaster focal persons assigned exclusively for disaster management ・High transfer rate of Dzongkhag focal person (DDM has to train newly assigned focal person from the beginning.)
		Conceivable solutions	・Trained DM officials and other relevant officials on DM and contingency	・DDM will assist to formulate the Plan for Paro and Trongsa Dzongkhags.	Preparation of a Planning Guideline by DDM (to be finalized in July 2014) to

	Subject		**Institutional and Social System Level**	**Organizational Level**	**Personal Level**
			planning guideline・DDM to facilitate and coordinate with Dzongkhags and formulate the plans to be implemented by the Dzongkhags	・Therefore, the flood risk assessment by JICA (Activity 1-3) and the hazard information collected through Joint CBDRM activity by DDM and JICA (Activity3-1~3) will be useful for the formulation in a timely fashion.	support Dzongkhag to formulate the Plan.
4	Flood Forecast and Warning System	Issues/challenges to be solved	・Social recognition of EWS and the policy priority in the Government is not high, since EWS is very new to Bhutan. ・Community's confidence in EWS seems not so high. ・Low awareness of community residents might cause the damage of equipment by stone-throwing or property loss. ・No institute to carry out training on EWS in Bhutan	・Only Punakha-Wangdi Valley has integrated EWS so far. ・New EWS installation project has a lot of budget, however, after the installation, the budget to maintain it is not enough .	・Need more training on EWS to develop more professional staff in this field ・Require more expertise in weather & climate field ・Gap between overseas training contents and everyday work
		Conceivable solutions	Awareness raising activity through media, seminar and workshop for students (the Project Activity) and CBDRM (Activity 3-1~3)	Installation of new EWS to Mangdechhu and Chamkharchhu basin according to 11th 5-year Plan (Activity 1-2 and 2-1~4)	・Provision of practical training on EWS and its operation and maintenance to DHMS staff (Activity 1-2 and 2-5)・Provision of practical training on improvement of flood and weather forecasting system (Activity 1-8)
5	Information Sharing in Emergency	Issues/challenges to be solved	・National Emergency Operation Center (NEOC) and District Emergency Operation Centres (DEOC)that shall act as an information nerve center have not been established yet. ・Clear information sharing mechanism (SOP) is not put in place	DHMS's GLOF EWS in Punakha-Wangdue Valley is the only integrated system which has information sharing in emergency based on SOP so far. Other basins do not have any such a system.	No professional Dzongkhag disaster focal persons assigned exclusively for disaster management
		Conceivable solutions	・Prompt establishment of NEOC and DEOC・Develop SOP on information sharing in emergency through discussion with relevant agencies (Activity 1-9)	New development of SOP in Mangdechhu and Chamkharchhu basins (Activity 3-4)	・Capacity development for Dzongkhag focal persons by continuous training by DDM・Recruitment and assignment of full time Dzongkhag disaster focal persons in several selected disaster prone Dzongkhag

3.1.4 1st Annual Seminar

The 1st Annual Seminar was held on June 19, 2015 aiming at sharing the Project progress and achievements with many stakeholders. Reflecting the high ownership of the Bhutanese side, most of the presentations were done by the C/P staff including the presentation by the DDM director. Around 60 participants, not only counterpart agencies, relevant agencies, district focal persons, donors, universities, media, NGOs but also VIP such as the Minister of Economic Affairs and several National Assembly members showed a high interest in the Project. The program and the participants list are shown in Appendix 8.

3.1.5 Counterpart Trainings in Japan

1) General

The Counterpart Trainings in Japan implemented seven times during the 1st Phase (September 2013 - July 2015) is as shown in Table 3.3.

Table 3.3 Record of C/P Training in Japan

Type of training course	Name of training course	Period		Trainee	
		Duration (days)	Date	Number	Organization
JICA ready-made	Capacity development for flood risk management with IFAS	28	Jul. 6- Aug. 2, 2014	3	DHMS 2 DoES 1
	Reinforcement of meteorological services	90	Sep. 10 – Dec. 8, 2014	1	Met. Division, DHMS
Project custom-made	Utilization technology on meteorological satellite data (SATAID) (objective: To improve weather forecasting through the study on SATAID)	12	Oct. 29 - Nov. 8, 2014	3	Met. Division, DHMS
JICA ready-made	Comprehensive disaster risk management administration	48	Jan. 7 - Feb. 23, 2015	1	DDM
	Strategy for resilient societies to natural disasters	55	Jan. 12 - Mar. 7, 2015	2	DDM DHS
Project custom-made	Technology on river management, EWS and weather observation (objective: To promote the Project activity through above study field)	12	May 10 – 21, 2015	6	DHMS:4 DGM:1 DoES:1
JICA ready-made	Capacity development for flood risk management with IFAS	28	July 6 – Aug. 2, 2015	1	Hydro. Division, DHMS

As for the IFAS related training mentioned above, the trainees evaluated the training was useful, since the contents was not only to learn the usage of IFAS software but also to understand overall flood mitigation in Japan such as flood forecasting and early evacuation of residents.

As for the Project custom-made course in May 2015, the trainees learned various disaster management in Japan from national, province, municipality, university and civil society. The trainees were interested not only in flood management but also in overall natural disaster management especially after the big earthquake that happened in Nepal in April 25, 2015.

2) Debriefing Session on C/P Trainings in Japan

The 1st Debriefing Session on the C/P trainings in Japan was held on April 17, 2015 at DHMS. The trainees who participated in the courses from July 2014 to March 2015 as in the above Table 3.3 and made presentations to widely share the knowledge and experiences with 21 staff of relevant counterpart agencies. The program is as shown in Appendix 9.

It is confirmed through their presentations that all the trainees learned a lot of useful things on disaster management and were very active and positive to share the knowledge and experience with other people.

3.1.6 Project Mid-Term Review and the 2nd JCC Meeting

JICA Headquarters dispatched the Mid-Term Review Mission from January 26 to February 13, 2015 to review the Project activity and achievement. The JICA Expert Team cooperated with the interview survey to C/P and relevant focal persons and field survey conducted by the Mission.

The 2nd Project Joint Coordinating Committee (JCC) meeting was held at DHMS on February 13, 2015. The meeting was attended by officials from central government agencies in Thimphu and disaster focal persons from two districts. The Draft Mid-Term Review Report prepared jointly by Bhutanese and Japanese sides was discussed and agreed, and the Minutes of the Meetings was signed and exchanged. Among the five review criteria, the relevance, effectiveness, efficiency and impacts of the Project is considered to be high and the sustainability is considered to be relatively high.

3.2 Achievements on Output 1 Activities

All the Project achievements on Output 1 “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced” in the 1st Phase (September 2013 - July 2015) are described in this section.

The following activities implemented in the 2nd Phase (October 2015 – September 2016) are excluded.

- Development of SOP on emergency information sharing through discussion and workshop with relevant agencies (Activity 1-9)

3.2.1 Present State of Existing Hydro-Met Data, Monitoring and Warning (Activity 1-1)

1) Evaluation of Meteorological and Hydrological Observation

(1) Hydrological Observation

i) Hydrological Observation Network

The hydrological observation network is shown in Figure 3.1. Primary and Secondary Stations were established to mainly provide hydrological information for water use sectors and gauge readers observe the water levels of rivers and conduct flow measurement at the stations. Flood Warning Stations were established to provide flood warning services and gauge readers observe the water levels at the stations. Real time AWLS have been installed to monitor the water level of rivers for flood warning.

A hydrological observation network covers all main rivers in Bhutan but it is recommended for the network to be expanded upstream for flood warnings to important cities in Bhutan.

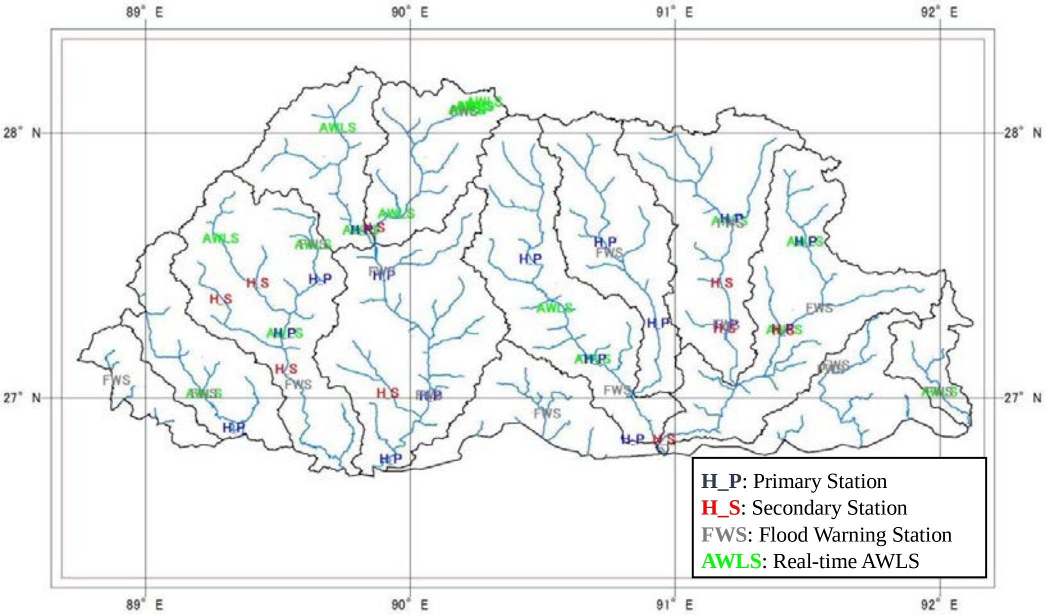

Figure 3.1 Location of Hydrological Stations in Bhutan (as of January 2014)

ii) Primary, Secondary and Flood Warning Stations

Settings of the observation instruments, observation, maintenance and data processing of Primary and Secondary Stations were checked and evaluated. Some stations have several names and it causes confusion among data users. This matter will be resolved by using only one name for each station.

The observed data of Primary and Secondary hydrological stations are periodically reported to the Hydrology Division of DHMS and applied quality control is done manually. The daily data are stored in HYDATA, hydrological database and analysis software. HYDATA can develop rating curves and calculate discharges (river-flow) with the gauge height data and the rating curves. The data of Primary and Secondary hydrologic stations were published in the data book of "Surface Hydrological Data of Bhutan" in 2009 with the cooperation of a JICA senior volunteer. All observed and calculated data are stored in HYDATA. The rating curve is shifted or reproduced after the changes of river configuration and the daily hydrologic data are satisfactory. A discrepancy in the stations can be found in the list of the stations and the data. Some stations have several names and several values of their latitudes and longitudes. These discrepancies cause confusion among data users. Similar discrepancies were found in the data of Flood Warning Stations. The following matters are recommended;

- To reproduce the site register book which defines unique name, station code, latitude, longitude and shows the position and elevation of reference datum of gauge height, the description of a site, the configuration of the rivers and their change, starting, stopping, resuming, the closing date of observation and their chronological information.
- To reproduce the list of observation sites based on the register book.
- To process all data by identified name and code shown in the reproduced list.

iii) Real Time AWLS

Setting of the observation instruments, observation, maintenance and data processing of real time AWLS were checked and evaluated. It is recommended that quality control be applied routinely on their data.

Real time AWLS were installed in order to provide timely warnings downstream since 2009. Flow measurements are conducted at few AWLS stations and the conversion of river stage to flow has not been made. Observed data are stored in databases but quality control has not been applied to the data. Missing, duplicates or doubtful data were found frequently in the raw data of real-time AWLS.

Real time AWLS will be the mainstream of the observation system. Their accurate data are very important and necessary for quantitative flood warning and the evaluation of water resources. The following are recommended to process the data of real time AWLS;

- Flow measurements will begin at high-priority stations
- Receiving data will be monitored routinely and duplicate data will be removed.
- In case the data cannot be retrieved through a communication system, the data will be downloaded from the data logger at the site.
- Wrong or doubtful data will be routinely monitored and the corrected data will be stored in a different database from the original data.
- All real time AWLS data will be monitored and stored in NWFWC after NWEFWC will be put in operation.
- It is preferable that a unified database will be created to process all AWLS data in NWFWC.

(2) Meteorological Observation

i) Meteorological Observation Network

Meteorological stations lie sparsely in mountainous areas and it is recommended to expand the meteorological station network, especially the rain gauge network in mountainous areas.

The meteorological observation network is shown in Figure 3.2. A lot of meteorological stations are located with one station in every 20 km square on average but the stations lie sparsely in mountainous areas. The distribution of annual average rainfall is shown in Figure 3.3. It shows a clear decreasing tendency towards the north, but also shows increasing tendency towards the far north. The figure cannot show clearly that a station at high elevation receives more rainfall in the stations along the same latitude. It is stated in chapter 3.3.1 that the rainfall at Bjizam or Chamkhar Station, the northernmost station in Mangdechhu or Chamkharchhu Basin, is less than the rainfall in the upper catchment area of each station. The present observation network provides inaccurate and underestimated rainfall in a basin. The rainfall observation in mountainous areas is very important and the installation of rainfall stations in mountainous area is recommended though their installation and maintenance is difficult.

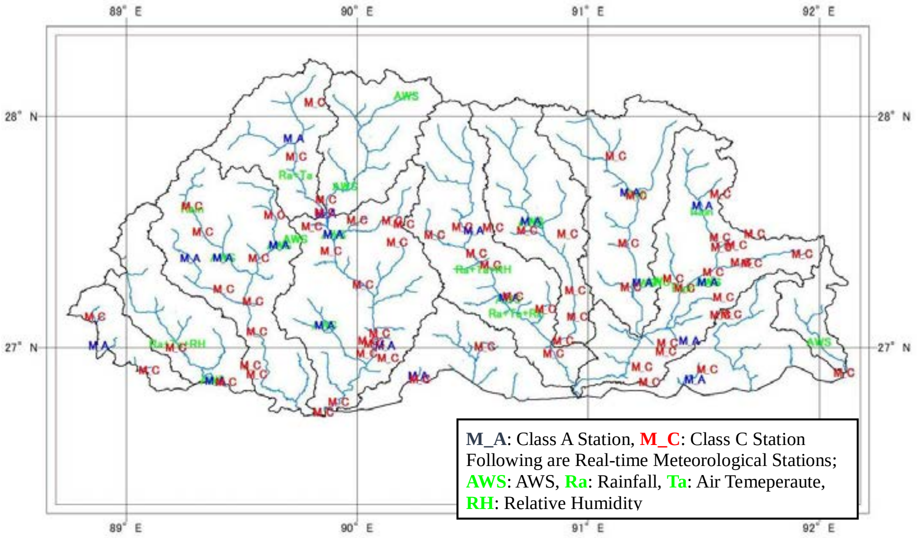

Figure 3.2 Location of Meteorological Stations in Bhutan (as of January 2014)

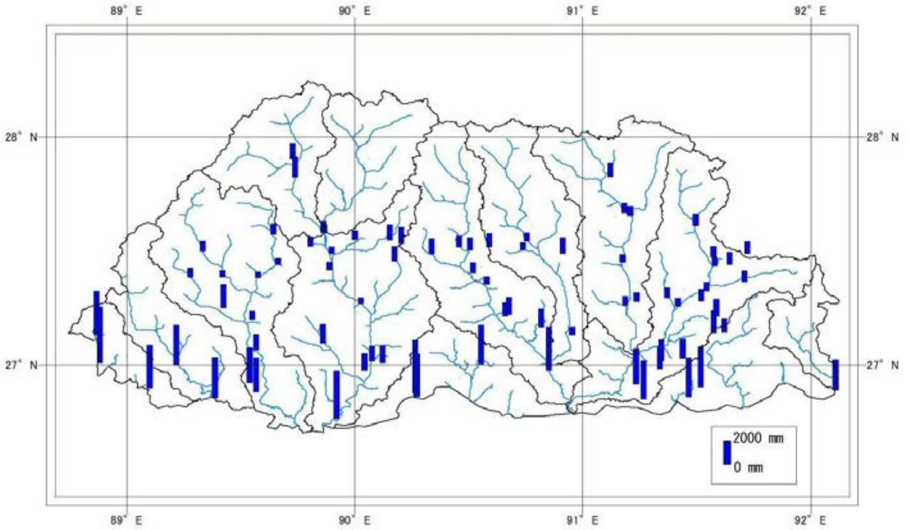

Figure 3.3 Annual Rainfalls of Meteorological Stations

ii) Class A and Class C Stations

Settings of the observation instruments, observation, maintenance and data processing of Class A and Class C Stations were checked and evaluated. The meteorological data obtained by observers must be processed and stored in a database after the reproduction of an accurate station list.

The observed data of Class A and Class C stations are periodically reported to the Meteorology Division of DHMS and stored in Microsoft Excel. The data are not managed well and are mostly managed by individuals. Different individuals keep different lists of stations and their data. A unified list of the meteorological stations and their data are necessary. Inadequate numeric values are used to explain missing data and it confuses data users. The following are recommended;

- To collect all lists and data of observation kept in the Meteorology Division
- To reproduce the site register book which defines the unique name and station code and shows the latitude, longitude, elevation, region, observing parameters as well as the name of instruments, the site description, their change, starting, stopping, resuming, closing date of observation and chronological information.

- To produce the list of observation sites based on the register book.
- To process all data by identified name and code shown in the list of observation.
- To create a database and original data that will be stored in it. If missing data are shown in numeric value, a physically impossible data value, for example, –999 for rainfall, must be entered in the data field.
- To apply quality control on the original data and the corrected information will be stored in a different database from the original data.
- To use a physically impossible data value for the missing data

Self-recording instruments are installed at every Class A station and the recorded sheets are kept in each station. A part of the recorded charts have been read and the read data have been sent to the Meteorology Division. These charts can provide hourly rainfall and rainfall intensities and they are important for the construction of a weather forecast system and the evaluation of climate change. It is recommended to read hourly rainfall and rainfall intensity from the recorded charts and to store these data in the database.

iii) Real Time AWS

Settings of the observation instruments, observation, maintenance and data processing of real time AWS were checked and evaluated. The network of real time AWS is being expanded intensively, but their data are not well processed and it is recommended to apply quality control on their data.

Real time AWS are being intensively installed in recent years. Most of the real time AWS are operated by the Meteorology Division of DHMS, but their data are stored in a different database constructed by each different project. Some of the real time AWS are operated by the Hydrology Division of DHMS and their data are not shared with the Meteorology Division. Quality control is not applied to the data of real tile AWS and missing or duplicate or doubtful data were found frequently in the original data. Retrieval of the data from the data logger at the site has not been made for the missing data

The data of real time AWS will be essential for weather forecasting and their importance will increase. The following are recommended to process the data of real time AWS;

- Received data will be monitored routinely and duplicate data will be removed.
- In case the data cannot be retrieved through the communication system, the data will be downloaded from the data logger at the site.
- Wrong or doubtful data will be routinely monitored and the corrected data will be stored in a different database from the original data.
- All real time AWS data will be monitored and stored in NWFWC after NWFWC will be put in operation.
- It is preferable that a unified database will be created to process all AWS data in NWFWC.

2) Coordination with GTS/MSS Related Organizations

As a part of Output 1, DHMS and WMO member countries is connected via the GTS/MSS network. This system enable DHMS to access various meteorological information and enhance DHMS's capability of meteorological analysis and forecasting. Figure 3.4 shows the GTS/MSS network in Asia. DHMS is present but not connected in the GTS. An implementation plan to connect GTS/MSS with DHMS was made. Thimphu and New Delhi is connected as the main circuit, Thimphu and Bangkok is connected as the backup circuit.

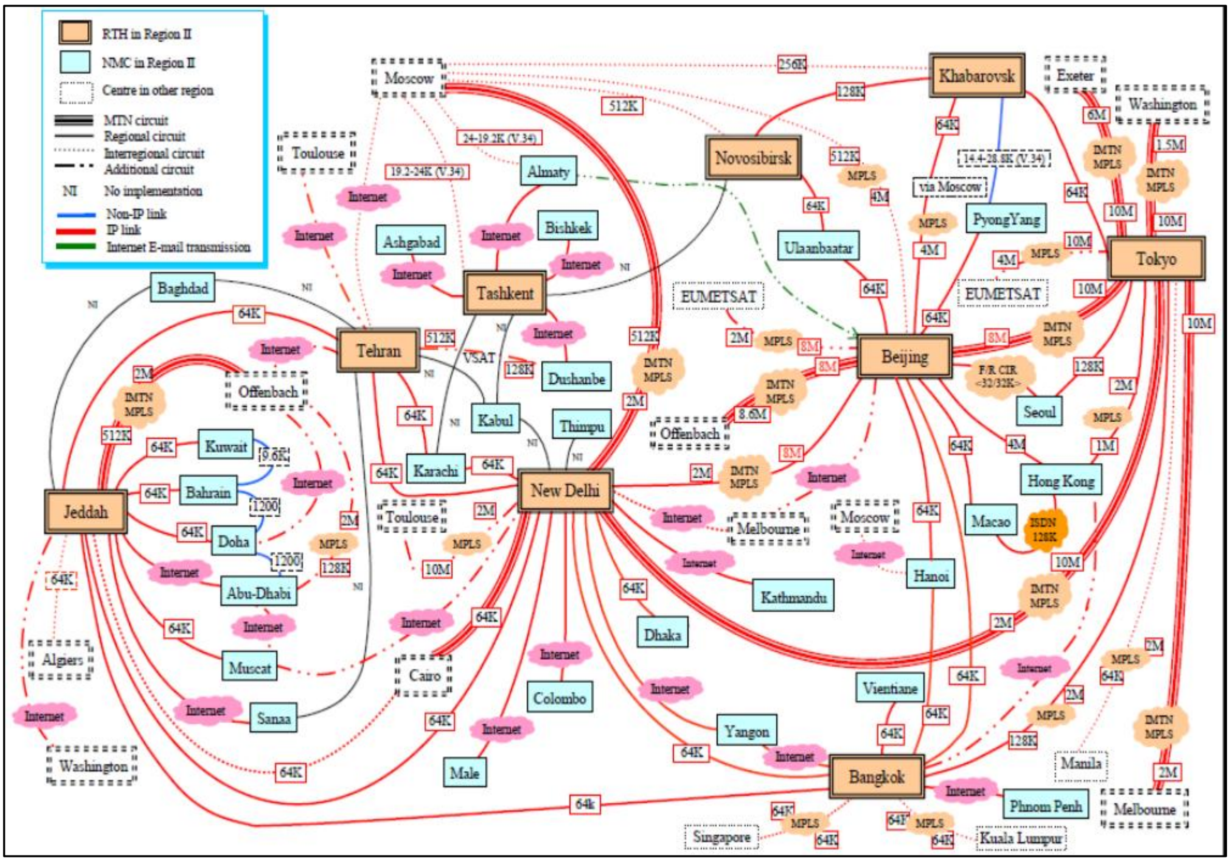

Figure 3.4 GTS/MSS Network in Asia

To install GTS/MSS, DHMS requires coordination with domestic and international organizations. The C/P of DHMS and Project experts are carrying forward the coordination. Table 3.4 shows the progress of the coordination in the 1st Phase of the Project.

Table 3.4 Progress Chart of Doing Action between DHMS and Related Organizations

	Related Organizations	Contact Person of DHMS	Status	Action Plan
1	WMO	Mr. Singay Dorji Met. Div.	Application Form of DHMS's observation stations was accepted by WMO. (Aug.2014)	DHMS will decide the observation stations and apply for WMO with these stations.
2	Indian Meteorological Department	Mr. Tayba Buddha Met. Div.	IMD approved to connect GTS between DHMS and IMD.	DHMS will provide information about the installation schedule of GTS, and will coordinate connection between DHMS and IMD.
3	Thai Meteorological Department	Mr. Tayba Buddha Met. Div.	Same actions as IMD are going on.	DHMS will provide information about the installation schedule of GTS, and will coordinate connection between DHMS and IMD.
4	Japan Meteorological Agency	Mr. Tayba Buddha Met. Div.	GTS Duty officer of JMA was introduced.	

	Related Organizations	Contact Person of DHMS	Status	Action Plan
5	EUMETSAT	Mr. Tayba Buddha Met. Div.	DHMS asked questions about the DCP application form and received answers from EUMETSAT.	DHMS will send the application form of the DCPs and consult about the installation of the DCP system.
6	BICMA	Mr. Kuenzang Hydr.Div.	BICMA generally agreed on the frequency allocation which DHMS requested.	After the DCP frequency is allocated by EUMETSAT, the DCP frequency will be requested by DHMS. HF frequency matters are under coordination between BICMA and the Royal Bhutan Army. After coordination, an official application form will be issued.

Coordination between DHMS and the Indian Meteorological Department (IMD) was advanced under cooperative support by DR. L.R.Meen. And coordination between DHMS and the Thai Meteorological Department (TMD) is taking place. DHMS also contacted the Bhutan Telecom/Internet Provider.

After the GTS/MSS is put in place, DHMS distribute observational meteorological data to the WMO member countries. Prior to the transmission of observational data, DHMS have to register the observation stations on the WMO record. DHMS do the registration procedure under the cooperative assistance of Mr. Mohan Abayasekara, An Observing Systems Division of WMO. Mr. Tsunoda of JMA was nominated as the contact person of the WMO Asian Region.

Observational data of AWS and AWLSs, which is installed on the rivers of Mangdechhu and Chamkharchhu, is transmitted to DHMS through the European Meteorological Satellite (METEOSAT) and GTS/MSS. DHMS is a user of the METEOSAT DCP system. To become a METEOSAT user, C/P and the JICA Expert Team continued to coordinate on the participation procedure.

As a part of Output 1, DHMS is connected with WMO member countries via the GTS/MSS network. This system enables DHMS to access various meteorological information and enhance DHMS's capability of meteorological analysis and forecasting. The GTS system, which Bhutan becomes a member country, belongs to WMO Region Area II (RA II). The DHMS's GTS is connected with India Meteorological Department (IMD) and with Thai Meteorological Department (TMD). DHMS is required to be registered on IMD and TMD, which are the Regional Telecommunication Hub of RA II. And also DHMS is required to be registered on the Department of Observation of RA II. The JICA expert assisted DHMS's registration procedures to these organizations.

The DCP system, which is developed over Mangdechhu and the Chamkharchhu river basin for the EWS observation stations, employs EUMETSAT Data Relay system. The JICA expert assisted DHMS about the coordination with EUMETSAT, such as the registration of DHMS's DCPs, the connection procedures and the test procedures.

The concrete progressions are described in the next section.

3.2.2 Installation and Operation of Equipment for Integrated System (Activity 1-2)

1) Draft the Technical Specification

The specifications of GTS/MSS related equipment and materials were drafted with careful attention to the following matters.

1) GTS/MSS is introduced to NWFWC in order to access various meteorological information which are produced by WMO member countries. This meteorological information is processed and displayed in a visual format.. This system is contribute to improve the ability of weather forecasters for the early warning of meteorological disasters.
2) Introduced GTS/MSS equipment and materials must meet the WMO Technical Standards.
3) The introduced DCP system should meet the EUMETSAT Technical Standards and WMO Technical Standards. Observational data of the Mangdechhu and Chamkharchhu rivers is transmitted to DHMS through the European Meteorological Satellite (METEOSAT) and GTS/MSS.

The specifications of GTS/MSS and EWS were drafted based on the baseline survey which was conducted in October 2013. On November 27, the draft specification was explained to C/P of DHMS and was generally agreed upon. Retouch and correction of specifications were made, based on the discussions with C/P about the registration procedure to WMO, the archive of observational data, etc. On December 16, the specification was accepted by DHMS.

On 7 February 2014, the specification was officially accepted at the First JCC meeting.

2) Discussion on Satellite Image Receiving Method

DHMS agreed to introduce satellite image receiving from the Japanese New Himawari through the Internet and direct image receiver instead of introducing the Chinese Feng Yun Series on May 8, 2014.

3) Preliminary Survey for Introduction of HimawariCast Receiving System

The HimawariCast Receiving System is introduced at DHMS during the 2nd Phase (October 2015 ~ September 2016).

The new Japanese Meteorological Satellite (Himawari-8) can acquire high resolution image data. Japan Meteorological Agency (JMA) converts this data and distributes to users via communication satellite. This distribution system is called HimawariCast. DHMS introduces the HimawariCast receiving system to utilize the high resolution satellite image. The information about the HimawariCast receiving system was collected from WMO and JMA.

Figure 3.5 shows the transition schedule of Himawari Operation which was provided by JMA.

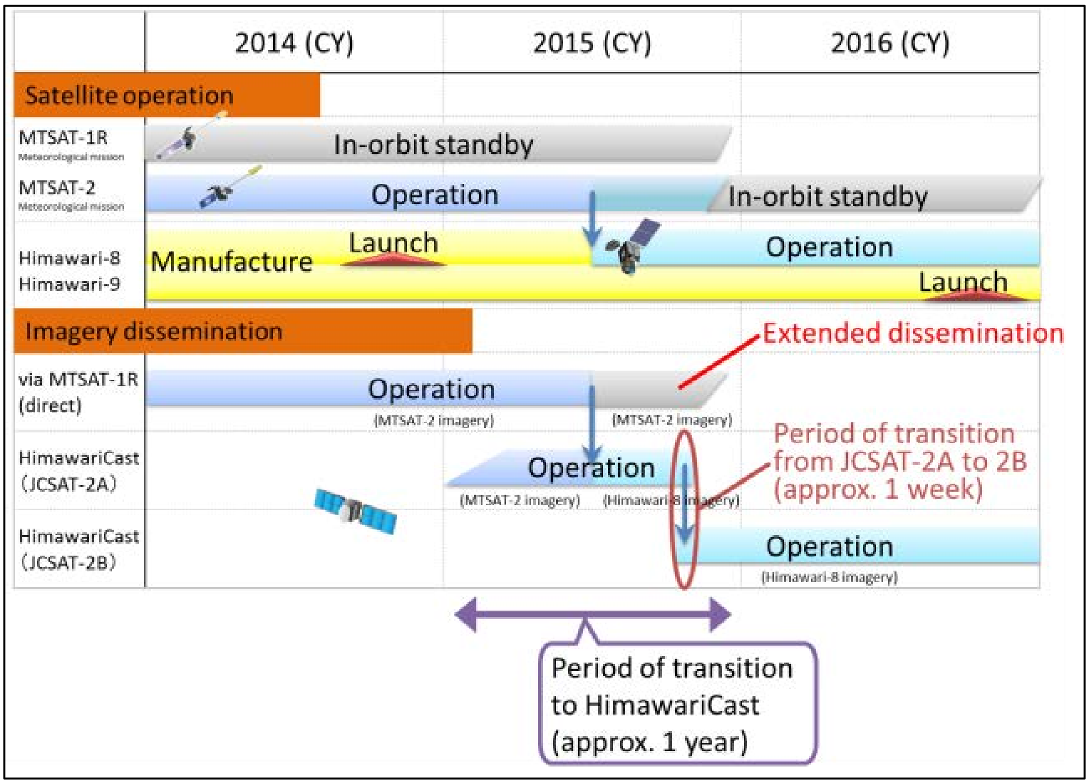

Figure 3.5 Transition Schedule of Himawari Operation

Since 24 April 2015, the JICA expert and the C/P investigated the installation place of HimawariCast Receiving System. After the installation of HimawariCast receiving system, the received high resolution image data contributes to utilize the SATAID program. The SATAID training for the DHMS's members was conducted in Japan, Nov. 2014.

Figure 3.6 shows the configuration of the HimawariCast Receiving System.

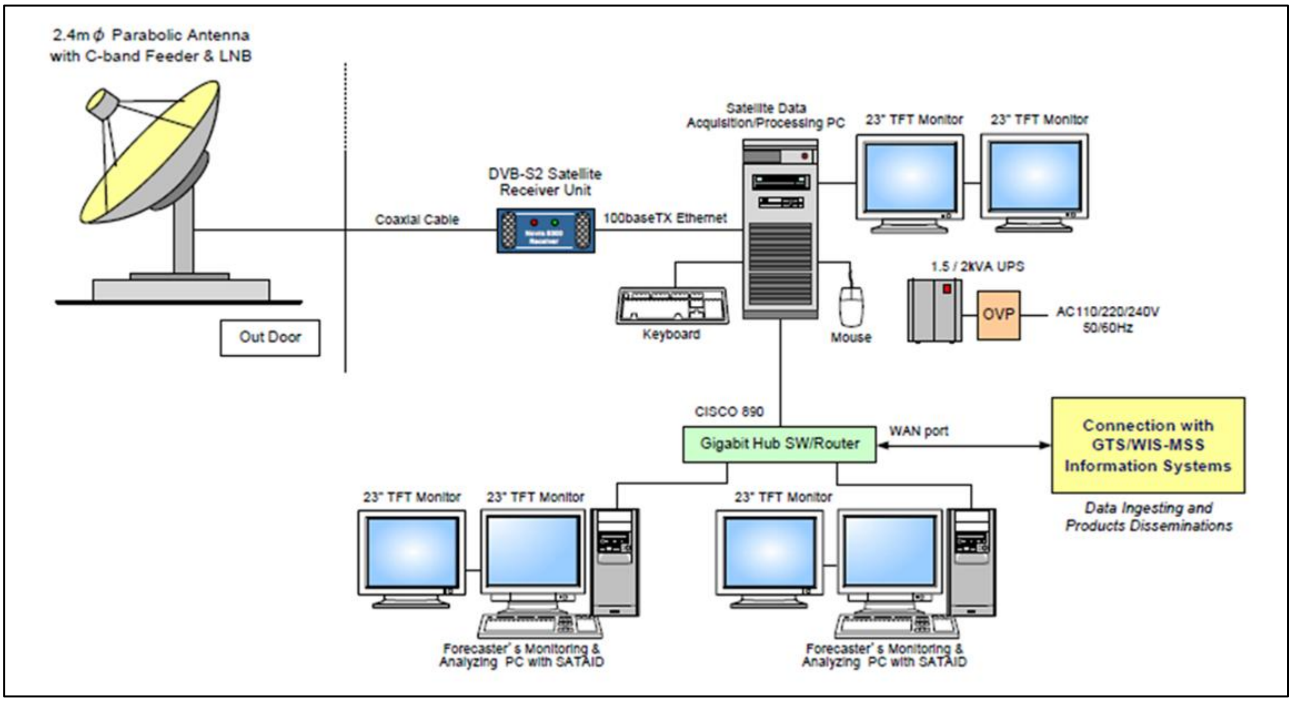

Figure 3.6 Configuration of the HimawariCast Receiving System

4) Assisting Field Preliminary Survey

The JICA Contractor of the GTS/MSS conducted a field inspection in October 2014. The JICA Expert Team assisted their investigation and coordination about the following items,

a) to layout the GTS/MSS in the new NWFWC. Figure 3.7 shows the layout of the GTS/MSS.

b) to connect between DHMS and IMD/TMD. Coordination between DHMS and the ICT division of DoES was conducted.

c) to prepare the Registration Form for DCP Administration. The Registration Form was submitted to EUMETSAT.

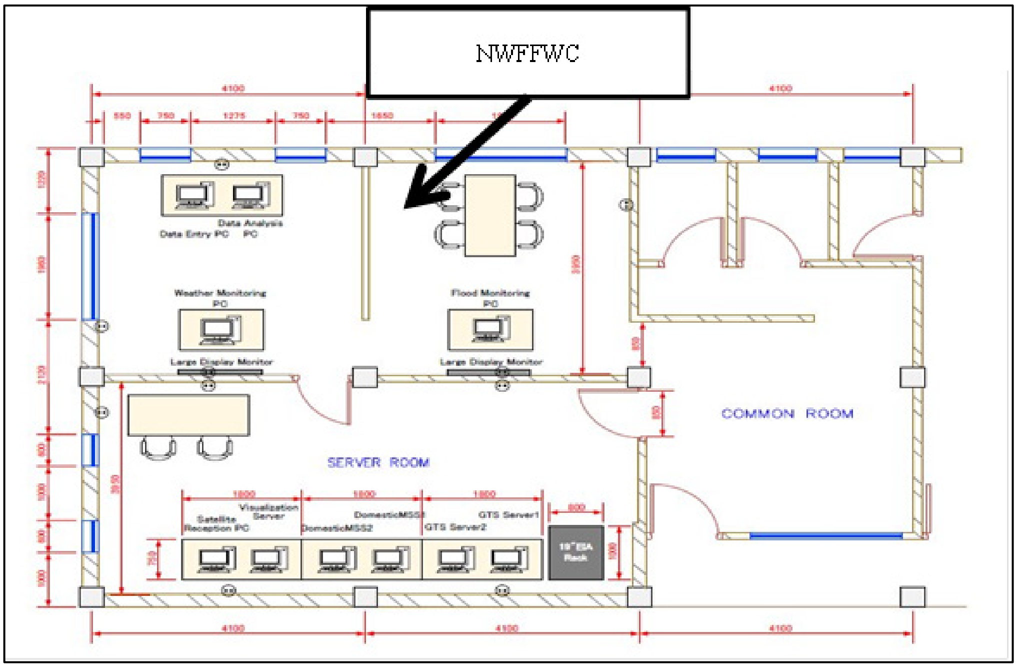

Figure 3.7 Layout of GTS/MSS

5) Pre-shipment Inspection

A factory assembly test was done by the JICA Contractor on February 2, 2015. The JICA Expert Team attended to the test and checked the full functions of each item except radio communications that should be done in the actual condition. The JICA Expert Team has requested the JICA Contractor to accelerate developing flood monitoring software which is the most important interface for the system operators.

Pre-shipment inspection was done by JICA on February 17, 2015. The JICA Expert Team has also joined to assist the inspection.

Factory Assembly Test

Pre-shipment Inspection

6) Assisting GTS/MSS Installation Work

During 22~28 April 2015, the JICA Expert Team assisted installation work of the GTS/MSS, that was conducted by the JICA contractor.

- 27 April 2015: The GTS/MSS circuit between DHMS and IMD was established. Also the DCP communication link between DHMS and EUMETSAT was verified.
- 8 June: EUMETSAT confirmed that all 5DCP stations data were received at Darmstadt.
- 10 June: The GTS circuit between DHMS and TMD was established.
- 3 July: All 5 EWS observation stations Data were confirmed by the GTS/MSS PC terminal at DHMS/ Thimphu. The communication route was, 5 observation stations => METEOSAT => Regional Telecommunication Hub in Germany => IMD => DHMS/ Thimphu

7) Preparation of GTS/MSS Operation and Maintenance Manual

To prepare the Operation and Maintenance Manual for the GTS/MSS, the role of WMO, relations between WMO and the GTS, the DHMS's responsibilities for the GTS/MSS, the DHMS's operational structure for the GTS/MSS were reviewed and discussed. The draft table of contents is as follows:

<u>Contents of the draft Operation and Maintenance Manual (DRAFT)</u>

1. Introduction
    - 1.1 Background
    - 1.2 Relation between the GTS and World Meteorological Organization
    - 1.3 The GTS Communication Link
    - 1.4 General responsibilities for the GTS Members
2. Functions and Responsibilities of the GTS
    - 2.1 Meteorological Information System
    - 2.2 Configuration of the DHMS's Communication System
3. GTS Management
    - 3.1 Meteorology Division
    - 3.2 GTS/MSS Operation
4. Operation and Maintenance
    - 4.1 Operation
        - 4.1.1 Start of the GTS system
        - 4.1.2 Monitoring the GTS system
        - 4.1.3 Trouble Shooting
    - 4.2 Maintenance
        - 4.2.1 Annually, Monthly and Daily Check
        - 4.2.2 Log Book
        - 4.2.3 Maintenance Tool
5. Duties and Responsibilities of the GTS/MSS Operator
    - 5.1 Duties and Assignment
    - 5.2 Shift Duty

8) Trainings Based on the Manual

To prepare the Operation and Maintenance Manual for the GTS/MSS, the following review and discussions were conducted.

- 8 May 2015: Discussion about the role differentiation about the contents of the Manual.
- 18 May: Review of the GTS operational structure of IMD.
- 25, 28 May: Discussion about the GTS/MSS operational structure of DHMS.
- 25 June: Presentation and discussion, concerning the Operation and Maintenance Manual, were held (7 members from Meteorology Division)

Presentation 25 JUNE 2015

3.2.3 Runoff and Flood Analysis Considering GLOF and Climate Change (Activity 1-3)

1) Launching of FHM Working Group

As revealed in the inception meeting and the baseline survey, a number of agencies have been conducting their own activities on flood risk assessment and hazard mapping in a haphazard manner. The National Disaster Management Act enforced in 2013 explains that the hazard zonation mapping shall be discussed in the Inter-ministerial Task Force.

The project has launched a Flood Hazard Mapping Working Group (FHM W/G) comprised of DHMS, DDM, DoES, DGM and NLCS, that could be a preliminary team of the following Inter-ministerial Task Force, to clarify the previous performance, human resources and legal basis of the relevant agencies, and to create a consensus between them on this activity. The performance and human resources of the relevant agencies are indicated as below.

Table 3.5 Previous Performance and Human Resources of Relevant Agencies

Organization	Previous Performance	Human Resources
Department of Hydro Met Services (DHMS)	DHMS is the responsible agency of hydro-meteorological observation, and providing the basic information for risk assessment to the relevant agencies.	A few staffs have been trained on flood analysis. A numbers of staffs have knowledge and skills on hydrology.
Department of Disaster Management (DDM)	DDM is the coordination agency to prepare hazard maps. DDM has collected information of relevant agencies in this field.	A few staffs have been trained on flood hazard mapping and GIS, but have less work experience.

Organization	Previous Performance	Human Resources
Department of Engineering Services (DoES)	DoES is an implementation agency of flood risk assessment in the 11th 5YR Plan. DoES has conducted studies on river works in the southern region.	A number of staffs have been trained on flood analysis. Some staffs can train the others Less work experiences because the division is newly created.
Department of Geology and Mines (DGM)	DGM was an implementation agency of GLOF hazard map in UNDP - NAPA project. The map was prepared without a hydrological method.	A few staffs have experience of GIS, but no experience in hydrology.
National Land Commission (NLC)	NLC is the responsible agency on topographical and cadastral map preparation based on the Land Act.	A number of staffs have board experience of GIS

2) Activities of Working Group

(1) Activities of Working Group

Discussion about establishment of working group for runoff/flood analysis and making a flood hazard map was done between DHMS, DDM and JICA Experts on Jan. 30th 2014. Based on the results of the discussion, the first Flood Hazard Mapping Working Group (FHM W/G) was held on Feb. 12th 2014.


FHM W/G

Participants of the FHM W/G are DHMS, DDM, DHS, DoES, DGM, NLC and JICA Experts. The main agenda is introduction of analysis training outline and establishment of guidelines for making hazard maps. It was confirmed that the guidelines are necessary for diffusion and development of hazard maps. FHM W/G should be held every two months.


Eroded Farmland

2nd FHM W/G was held on Apr. 30th 2014. The contents were a presentation from FEMD (Flood Engineering Management Division) /DoES about their mandates and a short report of the survey results in Bumthang and Bjizam. The schedule of training and other activities were also discussed. A memorandum of the FHM W/G is attached as Appendix 10.


Pit of Embankment

Preparing a runoff model is one of the FEMD mandates introduced at the FHM W/G. This operation overlaps the mandate of DHMS, but objectives for the runoff model construction are different (FEMD: structural countermeasure, DHMS: EWS and other wide application). Nonetheless, basic hydro-met data and topographical data for the model are the same. Thus, it seems better if they work in cooperation to reduce overlapping in operations.

The eroded river bank of farmland in Bumthang valley is shown in the right-picture. Settlements in Bumthang are usually situated on higher places. On the other hand, some farmlands are on the lowest river terraces. The farmland shown in the picture is only 2m higher than the river level in the dry season. Therefore, the river bank beside the farmland is eroded in the rainy season. As a result, fences fall down to the river bed. Countermeasures for the eroded farmlands are necessary from the view point of property protection. However, the priority of countermeasures to protect farmland is relatively lower than to save human life.

The pit of the embankment in Bumthang town is shown in the picture in the previous page. This pit may have been dug by local people for easy access to the river bank. This suggests that the local people have less realization of the risk of discontinuous embankment which has no resistance for river floods. The W/G members shared this information and confirmed the importance of an awareness program for disaster management such as CBDRM.

(2) Training

Training comprised of topographic surveys, runoff/flood analysis and GIS mapping were carried out for capacity development about flood hazard mapping. The schedule of the training and W/G is shown in Table 3.6.

Table 3.6 Schedule of Training and W/G of FHM (Feb.-Aug. 2014)

	Feb	Mar	Apr	May	Jun	Jul	Aug
Training (GPS, Analysis)	24th(DHMS, DDM), 26th(DHMS)	8th(DHMS) 20th(FEMD, DHMS)	8th,9th(FEMD,DHMS)		23rd-27th (all)		Technical operation support(DHMS,FEMD)
Survey at Pilot Site		24th-31st(DHMS,FEMD)		18th-25th (DHMS)			28th- 1st (DHMS)
W/G	12th		30th				

i) GPS/GLONASS Basic Survey Training

Training on GPS/GLONASS survey was carried out on Feb. 14th 2014 in front of the DHMS building. Participants were from DHMS and DDM, members of FHM W/G. In addition, training in the Thimphuchhu river bank were held on Feb. 26th and Mar. 8th for DHMS and on Mar. 20th for FEMD/DoES. Objectives of the training were proficiency of the GPS handling and accuracy testing of the GPS equipment. The recorded GPS data were imported into GIS and utilized for a HEC-RAS flood analysis test with DHMS C/P.

The GPS handling techniques were explained for DHMS C/P in advance. The DHMS C/P mainly instructed them in the training for the other C/P along with handouts of GPS handling prepared by the JICA Expert. The DHMS C/P got to be able to use the GPS/GLONASS survey equipment by himself.

GPS Training

ii) Runoff/flood Analysis Training

As a preliminary study, flood analysis training requested by FEMD was held at FEMD office on Apr 8th and 9th. Participants were 2 persons from DHMS and 6 persons from FEMD. GPS and total station data obtained by the training in the Thimphuchhu river bank were utilized as demo-data. Contents of the training were data import to GIS, making a TIN model, data export to HEC-RAS and steady/unsteady analysis on HEC-RAS.

HEC-RAS Training

Figure 3.8 shows a result of the steady flow analysis by HEC-RAS. Difference between observed water level and simulated water level by using observed discharge as the boundary condition is ca. 10cm. The JICA Expert stressed the importance of simulated result validation to complete proper analysis.

Figure 3.8 Example of HEC-RAS Analysis in the Training

Data collection, data preparation, review of existing information, survey data import into GIS and preparing handouts for following runoff/flood analysis training were done with DHMS C/P in May and June. Training materials for HEC-RAS were prepared by DHMS C/P based on the experience of previous HEC-RAS training at the FEMD office in Apr. The DHMS C/P joined in the following training as lecturer assistant.

The runoff/flood training was held from Jun. 23rd to 27th 2014. Numbers of participants were 24 from all C/P agencies (DHMS : 13、DDM : 2、DGM : 2、DoES : 5、NLCS : 1、DHS : 1). The training aims understanding of basic procedure of the analysis, required data and output of the runoff/flood analysis through practical lessons.

Contents of the training (Table 3.7) were decided as practical because it was judged that C/P can get many chances to join in “lecture” type training.

Most of the participants had no or limited experiences on runoff/flood analysis, but the total number of the participants exceeded our expections.. High interest and expectation for runoff/flood analysis were reflected by a lot of participants of the training.

Runoff/flood analysis training

Table 3.7 Schedule of Runoff/Flood Analysis Training

6/19 Thu, 20 Fri	Installation of software in advance
6/23 Mon.	Opening remarks by Director, DHMS Remarks by JICA Experts
	General information about FHM Previous study about the flood hazard
	Runoff analysis by IFAS to simulate flood discharge
6/24 Tue.	Runoff analysis by IFAS to simulate flood discharge
	Making GIS base map for pilot sites Calculation of probable precipitation and discharge
6/25 Wed.	Flood analysis by iRIC to estimate flood area and depth
6/26 Thu.	Making terrain data (TIN and raster) by GIS Flood analysis by HEC-RAS to estimate flood area and depth
6/27 Fri.	Mapping the result of flood analysis by GIS Extract settlements and facilities built on high risk area

iii) Support for C/P’s Routine Works

In order to transfer techniques, the JICA Expert supported C/P’s routine works with GIS operation and/or runoff/flood analysis such as making maps of observation sites and calculating the basin boundary/area.

iv) Outcomes of 1st Phase Technique Transfer

The experiences of training participants about runoff/flood analysis were limited (Table 3.5), but currently DHMS and FEMD C/P have started to conduct GIS operation and flood analysis in other projects. It is judged that their understanding of analysis is improved because they could recognize data errors and problems on flow simulation by themselves.

3) Runoff/flood Analysis Model Preparation

Runoff/flood analysis models and hazard map preparation for EWS operation, CBDRM and land use regulation is being conducted, cooperating with C/P and JICA Experts. The current state of the activities are described in the following sections.

(1) Basic Policy

i) Existing Hazard Maps

In the Chamkharchhu river basin, there are hazard maps prepared by DGM or DHS by using a geotechnical method. The distribution of predicted hazard areas on the hazard maps tends to be wide compared with the largest flood record, Cyclone Aila. In the Mangdechhu river basin, flood analysis for GLOF was conducted by SATREPS (2012). The other prior researches about flood discharge estimation for the Chamkharchhu and Mangdechhu River were implemented by hydropower plant projects. Those were utilized as references to decide input conditions of our analysis and to validate our simulated results.

ii) Target Areas and Input Analysis Conditions

Runoff/flood analysis target areas are the Mangdechhu river basin, Trongsa district and Chamkharchhu river basin, Bumthang district. Detailed flood hazard maps are prepared in the Bumthang valley flood plain area, near Choekhor Toe primary school and in Bjizam village, considering past flood records and topographic characteristics.

There is no definite standard for input analysis conditions to make flood hazard maps in Bhutan. Thus, input conditions are GLOF discharge, probable discharge in each return period and past largest flood discharge. It is better to choose a proper scenario for CBDRM, land use regulation after each scenario analysis is done. The FHM W/G put the scenario selection and review of existing/new simulated hazard maps on the agenda.

iii) Software for Analysis

Several flood analysis models such as Mike11 and Flo-2D were introduced to C/P agencies, but there are less actual achievements prepared by the models. In this project, C/P accepted that other free analysis software can be utilized so that plural C/P agencies can introduce and use the same analysis model. A list of analysis models are shown in Table 3.8.

Table 3.8 List of Analysis Models

Category	Software		Remarks
Runoff analysis	IFAS		Automatic satellite precipitation download and flood forecasting
Breach model	HEC-RAS(Dam breach)		Built in model of HEC-RAS
	BreachJ(NWS)		Detailed model settings
Flood analysis	2D	iRIC Nays2D Flood	2D analysis for flood plain and river bed (integrated)
	1D	HEC-RAS	1D analysis
GIS	ArcGIS		Distributed by NLCS

(2) Model Building

i) Basic Data Collection

Procedures of analysis, required basic data and examples of analysis were introduced on 1st FHM W/G on Feb. 12th 2014. The required basic data were requested for C/P to provide.

The provided data are shown in Table 3.9. GIS data provided by DHS were prepared by previous projects for Bumthang master plan and hazard map. A 10m resolution DSM prepared by SATREPS (2012) from ALOS-PRISM is utilized as the basic elevation data in this project. However, this DSM contains inaccurate data areas such as elevation errors under water surfaces and vegetation. Therefore, topographic surveys were done under collaborating with C/Ps.

The collected data were imported into GIS as basic data for survey and model building, cooperating with DHMS C/P. Those data were shared among C/P in the Training in June.

Table 3.9 Collected GIS Data

Category	Description	Provider
Hydrological data	Discharge, Water Level (Time series and location)	DHMS
Meteorological data	Precipitation, Temperature, …(Time series and station location)	DHMS
Building	Settlement, Hospital, Religious … (shape file)	NLCS, DHS, NSB
Infrastructure	Road, Embankment, …(shape file)	NLCS, DHS
Topographic map	Bumthang and Trongsa (shape file)	NLCS
Land cover	Bumthang and Trongsa (shape file)	NLCS
Control point	Bumthang and Trongsa (Excel, converted to shape file)	NLCS
Satellite image	ALOS-AVNIR2 GeoEye (Bumthang)	DGM(SATREPS) DHS
Elevation	ALOS-PRISM DSM	SATREPS

ii) Survey in the Target Basin

In advance of the survey in the target basin, exploration by JICA Experts was conducted for survey area confirmation and GPS equipment testing from Feb. 8th to 11th 2014. As a result, the interval of river cross-section survey of Japanese standard (ca. 200m) seems too short for Bhutan considering human resources. Thus, the interval of the cross-sections was decided as ca. 200m in important zones, like near villages and longer in other zones. C/P confirmed that on FHM W/G.

A test survey on Feb. 26th 2014 in Thimphuchhu river bank was conducted as C/P training and accuracy test of GPS equipment. Then, it appeared that GPS accuracy under unclear upward visibility was low. The JICA Expert discussed with C/P about this problem, and we decided to use both total stations owned by FEMD and GPS for the survey in the target basin. Training to import total stations and GPS was also carried out.

In order to collect hydro/topographic data for flood analysis, a cross-section survey was conducted from Mar. 24th to 31st 2014 in the target basin with DHMS and FEMD C/P. A second survey was conducted from May 18th to 25th to measure water level in the rainy season, new areas (Choekhor Toe primary school and small river in the Bumthang town) and error areas of the last survey. A third survey was conducted from Aug. 28th to Sep. 1st to collect the rainy season water level for model calibration.

The survey was mainly carried out along the embankment near the Bumthang Airport and properties to protect. The detected concerns were reported in 2nd FHM W/G. Obtained data were imported into GIS and utilized in the training.

Scene of survey (left) and embankment along the Bumthang Airport (right, height:ca.3m)

iii) Runoff Analysis

- Runoff simulation

Observed discharge at Kurjey gauging station on Chamkharchhu River, observed rainfall at Bumthang, satellite precipitation and simulated discharge by IFAS are shown in Figure 3.9. A similar analysis was done in the training in June. The simulated term is from May to Sep. 2009 including Cyclone Aila event. Reproducibility of the simulated discharge by using observed rainfall is higher than by using satellite precipitation data sets. Both timing and magnitude of the simulated discharge by using satellite precipitation does not match observed. The runoff parameters were calibrated by C/P training in Japan.

Both observed rainfall and satellite precipitation are deficient considering water balance in the basin in summer (see section 3.3.1). Possible reasons are 1) observed rainfall can’t measure high rainfall in mountainous areas because there is no meteorological station in the high altitude area 2) no consideration for snow/glacier melt discharge in summer. As for reason 1), satellite precipitation data sets should reflect the increment of precipitation in the mountainous area, but the satellite data doesn’t represent the tendency in this case. As for reason 2), the snow/glacier melt amount was calculated by positive degree-day method and snow/glacier area detected from satellite image at the end of summer. The calculated snow/glacier melt amount was inputted to IFAS, but the melt discharge amount was not enough to fill the deficit. The deficit amount in the summer corresponds to ca. 50m^3/s of base flow, which is relatively low compared with peak flow. Therefore, if the simulated discharge gains ca. 50m^3/s in summer, it seems no problem in practical operation when DHMS forecasts flood discharge.

- Probable rainfall/discharge

Table 3.10 shows probable rainfall and discharge calculated from observed data by using the Gumbel method, probable discharge calculated by using the

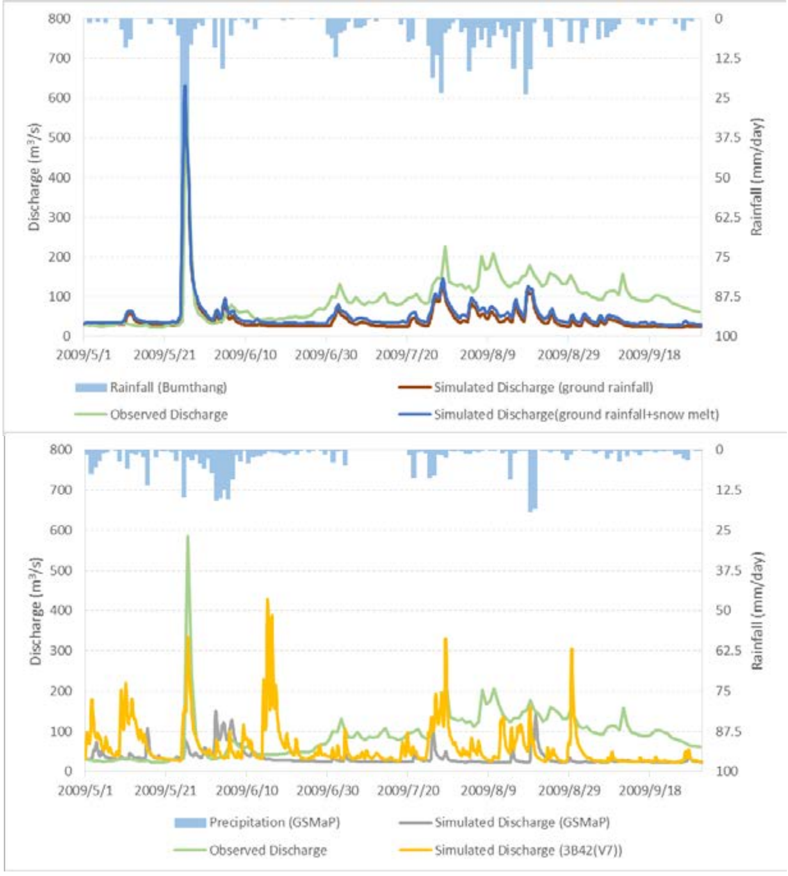

Figure 3.9 Simulated Discharge by IFAS (Kurjey)
(upper: observed rainfall lower: satellite precipitation)

Table 3.10 Probable Rainfall and Discharge

Bjizam	Rainfall		Discharge (m^3/s)	
	(mm/day)	(mm/3days)	observed	IFAS
2009 Cyclone Aila	95.0	203.4	642	690
20 years	75.2	96.3	466	327
50 years	87.4	106.9	524	424
100 years	96.5	114.9	568	491
200 years	105.6	122.8	611	573
500 years	117.6	133.2	669	676
1000 years	126.6	141.1	712	753

Kurjey (Bumthang)	Rainfall		Discharge (m^3/s)	
	(mm/day)	(mm/3days)	observed	IFAS
2009 Cyclone Aila	90.0	138.5	586	612
20 years	64.8	120.1	309	298
50 years	75.6	141.6	339	365
100 years	83.7	157.8	361	423
200 years	91.8	173.9	384	475
500 years	102.5	195.1	413	545
1000 years	110.5	211.2	436	610

※Rainfall/discharge in 2009 Cyclone Aila were excluded from calculation because those are plotted off Gumbel model probable rainfall and IFAS, and the past maximum discharge (Cyclone Aila, 2009) in the Chamkharchhu river basin (Kurjey, Bumthang) and Mangdechhu river basin (Bjizam). The parameters of the IFAS utilized on the analysis had been determined by C/Ps in the IFAS training in Japan

Mostly, calculated probable discharges by IFAS are larger than observed base probable discharges. This indicates that observed discharge, which records are kept only once a day, often miss peak discharge. Therefore, the probable discharges based on observed data may be of smaller value. The simulated probable discharge should be utilized to make flood hazard maps because of safety evaluation. This issue was discussed on the FHM W/G.

In addition, the calculated discharge will be converted to water level and applied to warning water level settings of EWS.

➢ Flood Analysis Scenarios

According to the result of the runoff analysis, the observed and simulated past maximum discharge (Cyclone Aila, 2009) are greater than the 100 years probable discharge. Therefore, the past maximum discharge calculated by IFAS was decided to be utilized for flood analysis as a rainfall flood scenario. Details of the flood analysis are mentioned in section 3.2.5.

iv) Glacial Lake Outburst Simulation and Flood Analysis

➢ Glacial Lake Outburst Simulation

There are many previous studies for GLOF in the target basins (e.g. SATREPS (2012)[1], Fujita et al.(2013)[2]). In this project, target glacial lakes were selected from the lakes which have high possible flood volume (Chamkharchhu basin: Cham_gl_198, Mangdechhu basin: Mngd_gl_270), by reference to the previous studies. Glacial breach modelling was conducted by using the BREACHJ(NWS) model. Landsat images of the glacial lakes from 1970's to the present were collected to evaluate the effects of climate change. As the result, the satellite images clarify that the areas of the target glacial lakes did not really increase. Thus, the recent lake areas were inputted to the breach model. Other parameters (e.g. moraine shape, grain size) were set by referring to ALOS DSM and the previous studies.

➢ Flow Simulation and Flood Analysis

An HEC-RAS 1D unsteady flow analysis was conducted in the Mangdechhu basin (from the lake to hydropower plant) and the Chamkharchhu basin (from the lake to downstream of Bumthang floodplain). The upper boundary condition was set from the simulated hydrograph of GLOF at the mouth of the glacial lakes. GLOF discharge, flood traveling time and rough flood area at each point in the basin were calculated by the analysis. The simulated GLOF discharge at Bjizam and Kurjey are 2,039 m^3/s and 3,254 m^3/s, respectively. These simulated GLOF discharges are one order of magnitude larger than the past maximum rainfall discharge. The estimated flood traveling time is following.

- From Jongthang: To Bjizam (34min), Dam site (50min), Power plant (88min)
- From Tsampa: To Kagthang (27min), Choekhor Toe Primary School (34min), Kurjey (60min), Bumthang downtown (83min)

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[1] Final Report of SATREPS Project "Study of Glacial Lake Outburst Floods in the Bhutan Himalaya", *Graduate School of Environmental Studies, Nagoya University*, June 2012

[2] Fujita, K., Sakai, A., Takenaka, S., Nuimura, T., Surazakov, A.B., Sawagaki, T., and Yamanokuchi, T. (2013) Potential flood volume of Himalayan glacial lakes, *Natural Hazards and Earth System Sciences*, 13:1827–1839, doi:10.5194/nhess-13-1827-2013

These estimated flood traveling time and river elevation profile extracted from Digital Elevation Model will be utilized for EWS operation.

(3) Detailed Flood Analysis and Preparation of Flood Hazard Maps

Detailed flood analysis by using detailed terrain models was conducted in prone areas where settlements are located in/near the flood area simulated in the previous section. The target prone areas for detailed analysis were near Bumthang floodplain, Choekhor Toe Primary School, Kagthang and Bjizam. The analysis was done by iRIC Nays2D Flood or HEC-RAS steady flow analysis. The simulated flood areas were exported to FHM (refer to 3.2.5).

(4) Flood Damage Estimation

The Total number of flooded buildings in the prone areas estimated from the simulated flood areas and GIS building data are shown in Table 3.11. The estimated total number of flooded buildings in Bumthang is much higher than the other areas. The number of flooded buildings in GLOF scenario is five times higher than the past max rainfall flood scenario. Damages to buildings by GLOF are hence a concern.

Table 3.11 Total Number of Buildings in Simulated Flood Area

		Past Max. Scenario				**GLOF Scenario**			
		Estimated flooding depth				Estimated flooding depth			
Location	Type	～0.5m	～3.0m	3.1m～	Total	～0.5m	～3.0m	3.1m～	Total
Kagthang	Residence	0	0	0	0	3	1	0	4
	Education	0	0	0	0	0	0	0	0
	Historical Place	0	0	0	0	0	0	0	0
	Health center/Hospital	0	0	0	0	0	0	0	0
	Commercial Building	0	0	0	0	0	0	0	0
	Farm Building	0	0	0	0	0	0	0	0
	Official	0	0	0	0	0	0	0	0
	Total	0	0	0	0	3	1	0	4
Location	Type	～0.5m	～3.0m	3.1m～	Total	～0.5m	～3.0m	3.1m～	Total
Choekhor Toe	Residence	0	0	0	0	0	4	1	5
	Education	1	0	0	1	0	0	1	1
	Historical Place	0	0	0	0	0	0	0	0
	Health center/Hospital	0	0	0	0	0	1	0	1
	Commercial Building	0	0	0	0	0	0	0	0
	Farm Building	0	0	0	0	0	0	0	0
	Official	0	0	0	0	0	1	1	2
	Total	1	0	0	1	0	6	3	9
Location	Type	～0.5m	～3.0m	3.1m～	Total	～0.5m	～3.0m	3.1m～	Total
Bjizam	Residence	0	0	0	0	0	0	0	0
	Education	0	0	0	0	0	0	0	0
	Historical Place	0	0	0	0	0	0	0	0
	Health center/Hospital	0	0	0	0	0	0	0	0
	Commercial Building	0	0	0	0	0	1	0	1
	Farm Building	0	0	0	0	0	0	0	0
	Official	2	0	0	2	0	3	1	4
	Total	2	0	0	2	0	4	1	5
Location	Type	～0.5m	～3.0m	3.1m～	Total	～0.5m	～3.0m	3.1m～	Total
Bumthang	Residence	1	0	0	1	6	30	4	40
	Education	0	0	0	0	0	1	0	1
	Historical Place	0	0	0	0	0	0	0	0
	Health center/Hospital	0	0	0	0	0	0	0	0
	Commercial Building	4	6	0	10	6	27	7	40
	Farm Building	5	1	0	6	0	9	3	12
	Official	0	1	0	1	0	1	0	1
	Total	10	8	0	18	12	68	14	94
		Past Max. Scenario				**GLOF Scenario**			

The building data utilized in the flood damage estimation contains some errors and lack of data. Thus, the building data should be updated continuously.

3.2.4 Enhancement of Coordination between Risk Assessment Sector and Development Sector (Activity 1-4)

It was agreed that Project activities related to administrative issues such as Activity 1-4 (enhancing coordination between agencies), Activity 1-6 (land use improvement), Activity 1-7 (institutional strengthening) and Activity 1-9 (information sharing SOP) will be implemented by Mainstreaming Disaster Risk Reduction Working Group (MDRR W/G) organized by working level C/P from all the six counterpart agencies. The MDRR W/G will be held once every two to three months.

On February 26, 2014, the 1st MDRR W/G workshop was held at DHMS with the attendance of all the C/P agencies. The main topics discussed were the establishment of the W/G, outline of MDRR and DDM's presentation on the status of Bhutanese MDRR and Disaster Management Act 2013 and baseline

survey result. On June 6, 2014, the 3rd MDRR W/G workshop was held at DHMS with the attendance of all the C/P agencies except DGM. The baseline survey was reviewed, discussed and updated by all the participants. The Minutes of the Meetings are shown in Appendix 11.

3.2.5 Preparation and Improvement of Hazard Map through Training (Activity 1-5)

1) Finalization of Flood Hazard Maps

The draft flood hazard maps which were prepared in Oct. 2014 were revised through terrain data modification, parameter calibration and revision of the runoff scenario. Finalization of the flood hazard maps was completed in Feb. 2015 in collaboration with a DHMS officer who is in charge. The target area of the hazard maps are Bjizam village under Trongsa district in the Mangdechhu river basin and Bumthang valley, Choekhor Toe Primary School and surrounding areas under Bumthang district in the Chamkharchhu river basin. Subsequently, local peoples requested analysis area extension and detailed flood hazard maps for each community through CBDRM (Activity-3). Thus, the JICA Expert and the DHMS officer conducted additional analysis and prepared detailed maps for each community.

Figure 3.10 shows the flood hazard maps in Bumthang (GLOF scenario and past maximum rainfall scenario). As a result of the revision of analysis parameters based on flood area records, the simulated flood water levels become higher than the height of the embankment beside the airport, and the airport area is flooded in both scenarios. The simulated flooding depth at the upstream of the elevated national highway in the Bumthang town is relatively high. In addition, inundation above floor level by GLOF is estimated at the Gangrithang Primary School. Hence, early evacuation drill by CBDRM activity using the EWS installed by this project is expected to reduce injuries.

These hazard maps can be utilized as references for urban development plans and CBDRM activities. Therefore, the GIS data of the hazard maps were shared among the C/P agencies. Evacuation sites, routes and other information decided by CBDRM activities should be added and updated on the hazard maps as needed.

2) Activities of Flood Hazard Map Working Group

(1) Activities of FHM Working Group

The 3rd workshop of Flood Hazard Map Working Group (FHM W/G) was held on Oct. 7, 2014. A topic of the workshop was the draft hazard maps in the Mangdechhu and Chamkharchhu river basin (see Appendix 10). Participants were from DHMS(3)、DDM(1)、DoES(2)、DHS(1) and JICA Experts(3). Comparison between the draft hazard maps and existing hazard maps and necessity of presentation to directors of the relating agencies were the contents of the discussion. Especially, if there is large difference between the hazard maps prepared by this project and the existing hazard map utilized by DHS as a reference of Bumthang Valley Development Plan, severe impact is estimated on the resettlement plan and land use restriction. Thus, review of the two hazard maps is necessary after the project hazard map is finalized.

The 4th FHM W/G workshop was held on Feb. 24, 2015. The topic of the workshop was the finalized flood hazard maps in the pilot basins. Participants were from DHMS(6 including director), DDM(1), DGM(1), JICA Experts(3). A participant suggested that the standard for flooding depth classification in Japan (underfloor inundation:-0.5m, ground floor inundation:0.5m-2.0m or 3.0m, upstairs floor inundation: more than 2.0m or 3.0m) is applicable for Bhutan, and this comment was agreed to by the participants. The other comment was about disaster damage and cost estimation. In the future, the Bhutan Government should decide plans of flood countermeasures considering the cost-benefit balance estimated from the cost of flood countermeasures and the calculated amount of

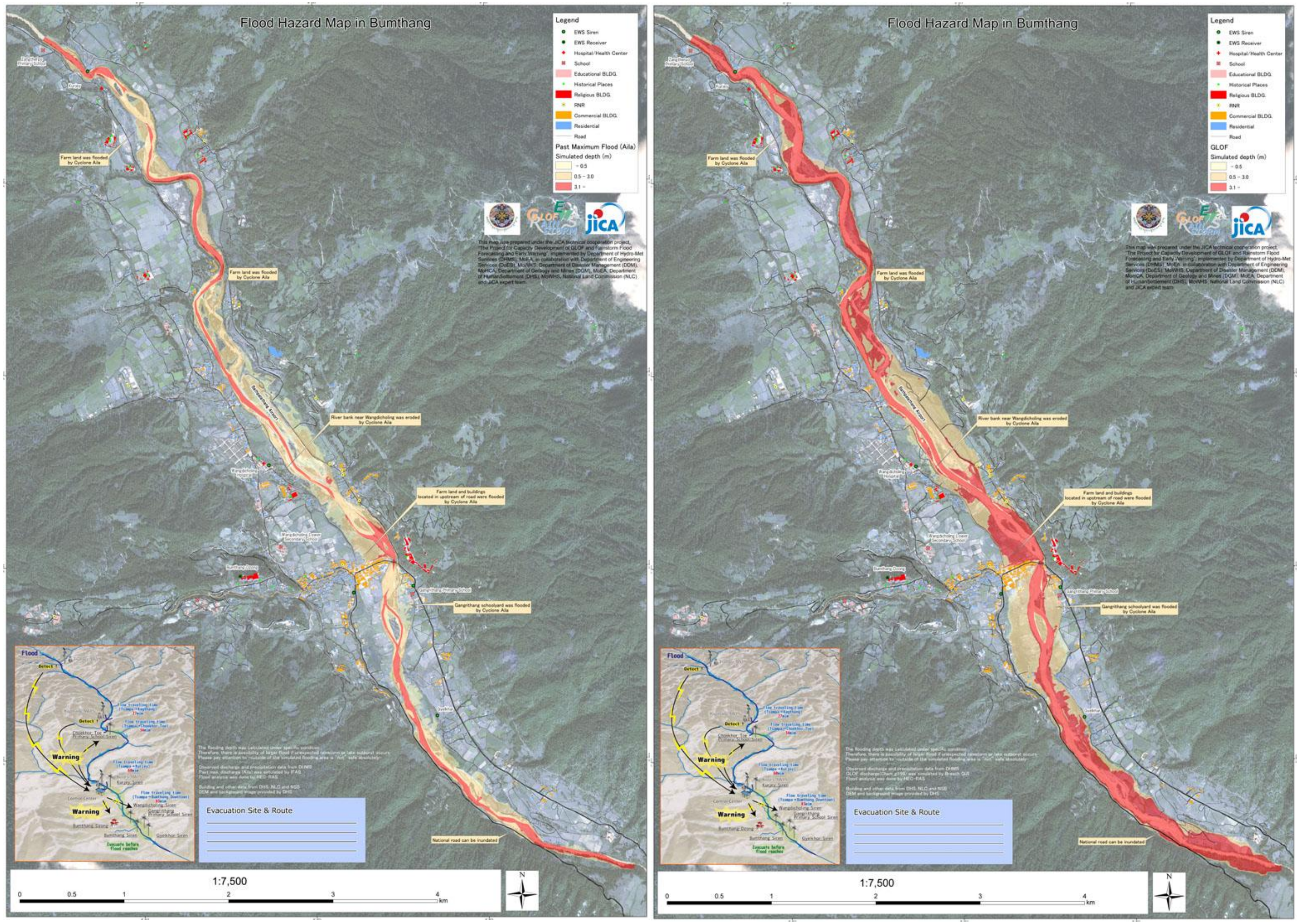


Figure 3.10 Hazard Maps in Bumthang
(left：Past maximum rainfall scenario, right：GLOF scenario)

flood damage based on the flooding probabilities and the inundation areas estimated by this project. However, insufficient social wealth data is a big problem to estimate the cost and benefit balance. Outline of other discussions is described in Appendix 10.

(2) Comparison between Flood Hazard Map and Bumthang Valley Development Plan

The DHS officer who is in charge of urban development planning could not attend the 4th FHM W/G workshop. Thus, JICA Experts set another meeting with the DHS officer and discussed about the difference between the hazard area of this project's hazard map and the DHS's development plan based on the existing hazard map.

Most of the hazard area estimated by this project is in the restricted development area of DHS, but three significant differences were found (Figure 3.11). Among these areas, the locations where the DHS restricted development area is narrower than Project's hazard area is set as non-residential areas such as stadium and storehouses near the airport. Therefore, it seems there is no serious problem. On the other hand, the area where planned restricted area is wider than Project's hazard area is currently used as a residential area. The flooding risk in this area is relatively low since the area is located on the high river terrace. This issue was discussed in MDRR W/G workshop (refer to 3.2.6).

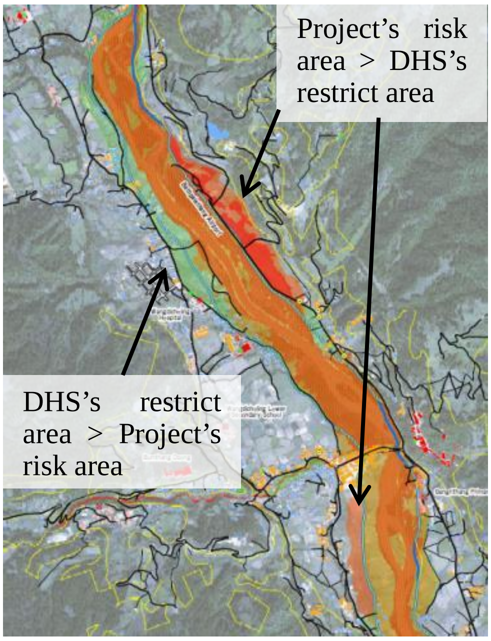


Figure 3.11 Restricted Development Area by DHS and GLOF Hazard Area by the Project
(green: DHS's restricted area, red&orange: project's hazard area)

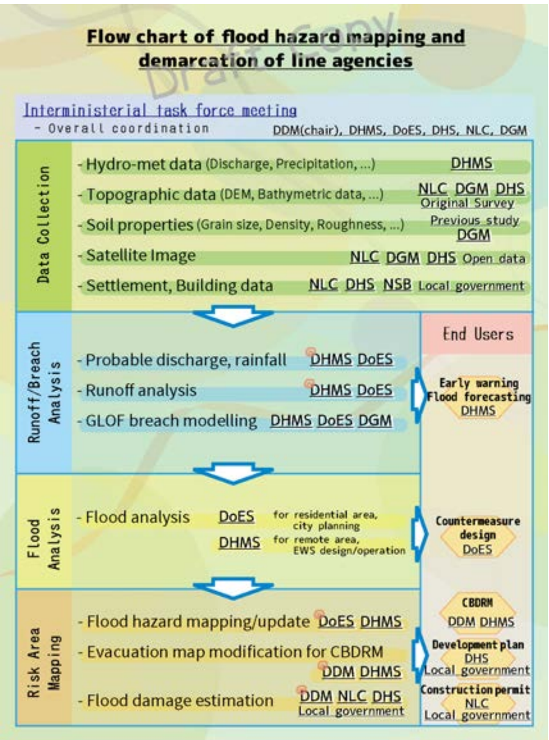


Figure 3.12 Tentative Roles of Related Agencies on Flood Hazard Mapping

The airport has a plan to extend the runway to the north area which is a former river bed. This area has high flood risk because the area is still in the simulated GLOF/Rainstorm inundation area. It is necessary to improve safety against floods by river bed excavation and embankment strengthening when the government starts the runway extension.

3) Preparation of Flood Hazard Map Preparation Manual

Technical parts of the hazard map preparation manual were prepared and utilized in the training and OJTs of runoff and flood analysis. These materials are modified and revised as the flood hazard map preparation manual by FHM W/G.

In addition, flowchart and tentative roles of each agency on the flood hazard map preparation (Figure 3.12) were prepared taking account the result of interviews with the each agency. The comments of the agencies are shown in Table 3.12. The roles of each agency will be discussed and decided by IMTF which will be established after FHM W/G based on the Disaster Management Act. 2013.

Table 3.12 Comments of the C/P Agencies on Flood Hazard Mapping

Agency	Comments
DHMS	- The following demarcation about FHM preparation was suggested. FHM preparation near settlement area (related to urban development) - DoES FHM preparation near Remote area (related to EWS) - DHMS - CBDRM activities are mainly done by DDM, but DHMS should also touch the CBDRM activities since the activities are strongly related to EWS.
DDM	- NDMA, which is headquarter of the disaster management administration, decided to establish IMTFs for each disaster type. Currently, there is less inter-ministerial information sharing about the disaster management. Thus, activities of IMTF are important. - The flood hazard maps will be submitted and officially approved by NDMA.
DHS	- DHS is basically an end user of the FHM, but DHS can provide data for analysis in some urban areas. - Currently, the urban development plans were provided taking account of distance from rivers only or hazard maps which were prepared by outsourcing. If the Bhutan Government can evaluate the disaster risks by themselves, that is helpful for the DHS's works. - DHS hopes DDM, which has jurisdiction on overall disaster management, joins to meetings to explain urban development plans including restricted development area to local residents.
NLCS	- NLCS is a provider of the data for the risk analysis and an end user of FHM. - NLCS has basic data for the flood damage estimation such as construction regulations and land use type. However, these data is only regulation. NLCS does not hold data of actual land use conditions in risk areas. Therefore, field survey is necessary to estimate the amount of flood damage. - After the high risk areas are approved by NDMA/IMTF, the risk areas are able to be reflected into land use regulations.
DoES	- The probable rainfall and runoff analysis are necessary to design embankments and other countermeasures. Therefore, DoES also conducts the analysis besides DHMS. - The flood analysis is one of the duties of DoES. However, the analysis contains hydrological parts. Thus, DoES hopes collaboration with DHMS on the hydrological parts. - The roles of each agency on the FHM preparation should be discussed after IMTF will be established.
DGM	- DGM had no clear duty on the FHM preparation, but DGM can help it when other agencies give some requests to DGM. - DGM can provide glacier lake bathymetric maps, soil test results, satellite images and other related data.

4) Trainings on Runoff and Flood Analysis

(1) OJT on FHM Preparation

OJT to the DHMS officer, who is in charge of FHM, on the FHM preparation in the pilot basins was continuously conducted from Dec. 2014 to Mar. 2015. In addition, technical support for flood analysis was also conducted for the other DHMS officer. These OJTs were done using the technical texts which become the parts of the FHM preparation manual. The DHMS officer who was trained by the OJT conducted a training for flood analysis to a DoES officer on Apr 22, 2015.

(2) Technical Cooperation along C/P's Regular Works

The JICA Expert joined as an observer to DoES preliminary survey for flood countermeasure design in Haa district on Feb. 3, 2015. In addition, the JICA Expert joined DoES river cross-section survey and conducted a field lecture about GPS survey in Haa district on Jun. 5 and 6, 2015. The cross-section data obtained by the field survey was utilized in lectures to import the river bed shape to GIS and flood analysis. A list of the conducted C/P trainings, lectures and OJTs in Dec. 2014-Jul. 2015 are shown in Table 3.13.

Table 3.13 Records of C/P Trainings, Lectures and OJTs (Dec. 2014-Jul. 2015)

C/P agency	DHMS	DoES	DGM
Contents	OJT/support for FHM preparing	GPS/GIS/runoff analysis/flood analysis	Glacier lake breach modelling
Period	2014 Dec. -2015 Feb.	2015 Feb.3, Apr.7,22, Jun.5,6,9,12,15,17,22, Jul. 9	2015.Jul. 8
Number of participants	2	6	5

3.2.6 Awareness Raising on Land Use Management against Disaster (Activity 1-6)

On December 10, 2013, an interview survey to DHS was conducted and collected about information on the proposed legal system on land use (Spatial Planning Act) and proposed national land use map development project to be implemented by NLCS and DOA jointly.

On February 2, 2014, an interview survey to NLCS was conducted and the following information on Land Act 2007 was collected.

- Land ownership concept, land acquisition method, basis law for land use regulation by local government
- Land use zoning formalities in regional development planning with local government including cooperative field reconnaissance (As for Bumthang Master Plan, DHS, Bumthang district government and NLCS will follow the same formalities in future.)
- Land use regulation formalities in landslide hazard zones to be conducted by DGM, local government and NLCS including corroborative field survey.

On March 7, 2014, the 2nd MDRR W/G workshop was held. The agenda was 1) presentations on land use management in hazard areas by W/G members and free discussion. The Minutes of the Meetings of the workshop are shown in Appendix 11.

DHS is the actual responsible agency to formulate district development planning on behalf of the district government. DHS formulated Bumthang Valley Development Plan (as Master Plan) in 2013 with the cooperation of Zurich City, Switzerland (Figure 3.13). Then, DHS drafted the Local Area Plans (as Action Plan with detailed land use planning) in 2014 for three priority areas selected from the Master Plan.

The 4th Workshop of Mainstreaming Disaster Risk Reduction Working Group (MDRR W/G) was held on April 10, 2015 with 14 participants from all the C/P agencies. The Minutes of the Meeting are shown in Appendix 11.

In the Workshop, based on the Draft Local Area Plan around Kurjey (Figure 3.14), the discussion on how to incorporate DHMS/JICA GLOF/flood hazard zonation and DGM GLOF hazard zonation into DHS Local Area Plan was held. In conclusion, with the attendance of the coordinating body, DDM, all the participants agreed DHS to take two hazard zonations into the Draft Plan. There was actually no change in the Draft Plan, since DHS flood hazard area prepared by a local consultant as a basis for the planning was safer (wider) side compared with DHMS/JICA and DGM zonation.

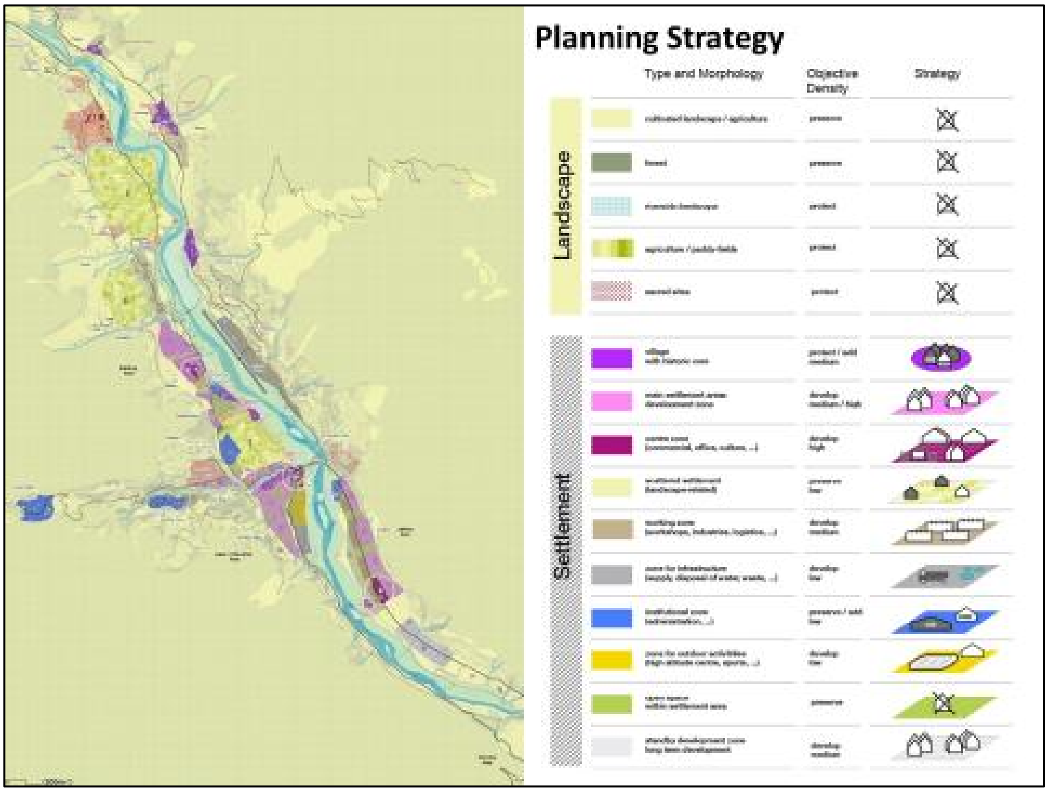


Figure 3.13 Bumthang Valley Development Plan (Master Plan) by DHS

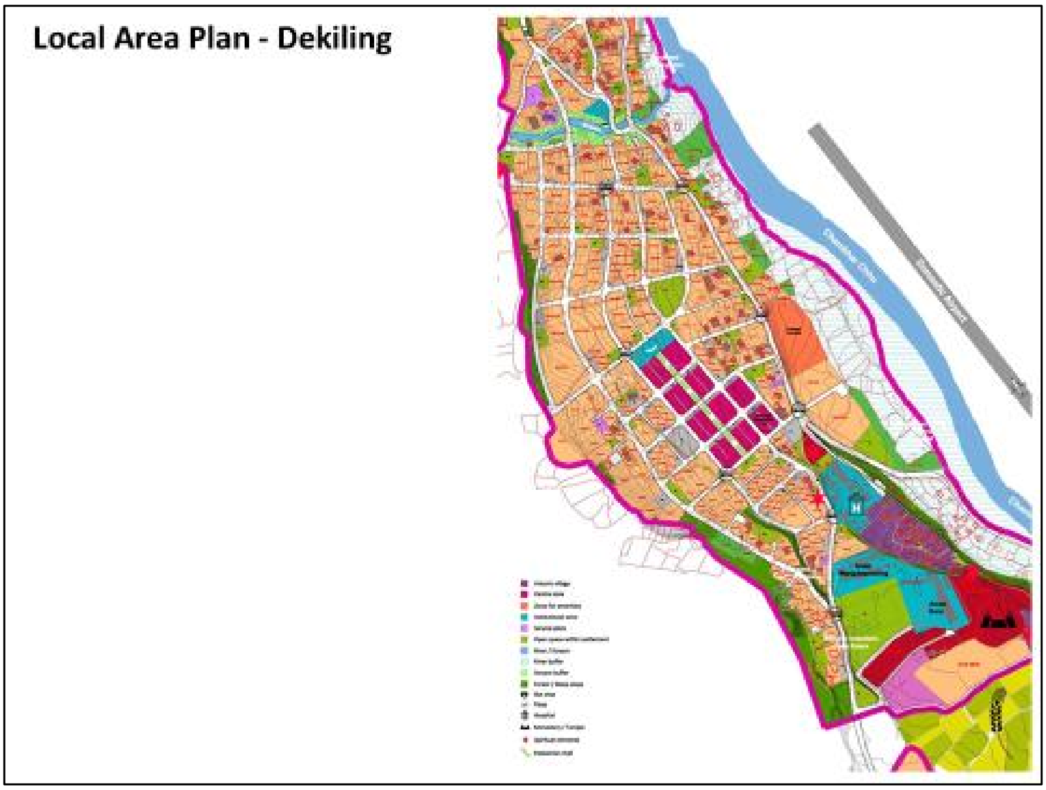


Figure 3.14 Draft Local Area Plan (Action Plan) by DHS
(Priority area around Kurjey)

3.2.7 Institution and Legal System for Mainstreaming Disaster Risk Reduction (Activity 1-7)

The present status and issues of relevant agencies for institutionalization of the relevant system and rules and regulations based on Disaster Management Act 2013 were investigated through the review of existing documents and discussion with DDM. The responsible agency of the development plan (DHS) and the planning system (DHS, district government, NLCS and the collaboration between risk assessment sectors and DDM) were studied through the above 4th MDRR W/G Workshop.

Following the Nepal large earthquake in April 25, 2015, the establishment of a national disaster management system, especially the institutionalization of Emergency Operation Centre (EOC) were highlighted as national priority issues according to the Disaster Management Act 2013. However, the issue to be solved is that DDM has no SOP and know-how in this field so far. Accordingly, the practical institution and legal system is proposed through the discussion in MDRR W/G Workshop in the 2nd Phase (September 2015 – September 2016).

3.2.8 Flood and Weather Forecast Utilizing the Numerical Weather Prediction (GPV) (Activity 1-8)

1) Current Status and Problems of the Weather Forecast in DHMS

In this project, a short term expert of weather forecasting is dispatched to improve the weather forecast system of DHMS. To prepare the terms of reference for the short term expert of weather forecasting, a basic survey about the DHMS service was conducted. The items of the survey were concerned with the organization, business in charge, operational procedures of weather forecasting, available meteorological information and archived meteorological data. There were several problems that had to be looked into.

To conduct operational forecasting, the meteorology division is mainly using 20 domestic observation stations data and other relevant meteorological information which are obtained via internet. DHMS doesn’t analyze its own weather charts, there is no archive of past data which is ready for operational use.

Based on the present condition of the Meteorology Division, terms of reference for the short term expert of weather forecasting were created.

1) Organization of the Meteorology Division

The Meteorology Division is composed of Meteorologists, Engineers, and Technicians. Many members are engaged at local observation stations. Figure 3.15 shows the organization of the Meteorology Division.

Meteorological Division is composed of following 36 members.

Meteorology Division: Chief 1
- Agromet/Climatology Section: 0
- Operation and Maintenance Section: Chief:1
    - ・ Construction and Instrumentation Unit: 3
    - ・ Weather Forecasting Unit: 5
        - ▸ Regional Meteorological Station: 20
    - ・ Data Processing Unit: 5
- Aviation Meteorology Section: 1

NWFWC consists of the members of Weather Forecasting Unit and the members of the Flood/GLOF Warning Unit.

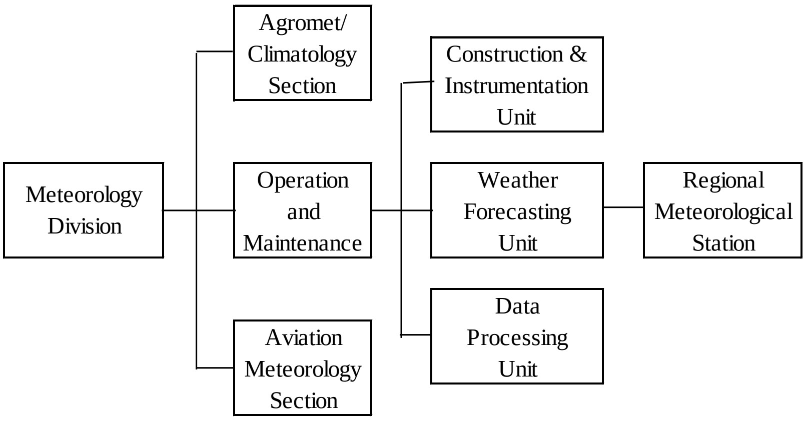


Figure 3.15 Organization of Meteorological Division

2) Jurisdiction of Meteorology Division

- Implementation of the meteorological plan, programs and policies of the department.
- Provide daily weather forecast information to the public based on observation and study of various models
- Research and studies on long range forecasts, prepare seasonal forecasts (monsoon outlook) annually for information to the public
- Study/observation of extreme weather events like cyclone and heavy rainfall for press release and timely information to the public. Analysis and research works on climatic data for specific purposes
- Planning of meteorological network and establishment of new stations

- Establish and operate telecommunication network for the rapid exchange and dissemination of observed hydro-meteorological information
- Operation and maintenance of existing meteorological network (9 real time AWS, 20 Class A, 61 Class C stations) across the country
- Meteorological data collection, quality control, archiving and database management. Provide climatic data and services to the Government for planning of developmental activities including private sector for specific studies and projects
- Data processing in coordination with PCRD for archive in a central database for statistical analysis, dissemination and publication
- Collect and provide aviation forecasts services in the future

3) Current status of operational weather forecast

More than 70 percent of the Bhutanese population are farmers and are faced with lots of challenges due to limited access of information on climate change. The Meteorology Division has started basic weather forecasting for the entire country (20 districts) only from October 2007. The present forecast is basically the weather outlook and the maximum/minimum temperature for 24 hours.

a. Routine operation of weather forecasting

Routine operation of weather forecasting is conducted by 1 shift forecast team (2 members). Operation time for weather forecasting seems 3-4hours. Because of the shortage of latest meteorological data and of inadequately archived data, it is difficult to realise a correct/timely weather forecast.

- Operation procedure of weather forecasting

During the morning: Access Web Sites, such as IMD, TMD, MetGIS, and so on. Forecasters get observational data, analysed weather chart, satellite image, numerical weather prediction, etc.

During the afternoon: Observational data are collected from 20 manned observation stations. Using these data and the collected Web site information, forecasters consider the daily weather forecast for the entire country (20 districts) and provide the forecast to the public.

b. Weather analysis and available information

- DHMS does not draw up its own Weather Charts. Weather analysis is conducted by using internet accessed weather charts such as analysed by IMD, TMD, and Bangladesh Meteorological Department (BMD).
- Indian Meteorological Satellite Images are accessed via Internet.
- Bhutan is in a high mountain area, but upper air analysis is not carried out.
- The prediction of minimum and maximum temperatures are conducted by using the Mori Model, this prediction is based on the accumulated 17 year data, temperature data report from 20 observation stations and meteogram information from India.
- Archived data, such as rainfall data and/or weather charts, are not used during routine forecasting operation.
- The Weather Research and Forecasting Model of NOAA is not in use, because it is difficult to get near real time data via the Internet.

c. Data Management

- Observed meteorological data are not systematically archived and also the quality control of data is not so good.
- The Operation and Maintenance Section has many tasks, which are related to make up the plan of a new observation network and installation works (including observation system supported by international donors). This Section visits and maintains the existing 9 real time AWSs, 20 Class A stations and 61 Class C stations. But some of the observation stations are not operated because of lack of spare parts.

4) Past records of Training for Capacity Development

Training for capacity development has been carried out as follows. Almost all of the training, except JICA's Meteorological training, were conducted for few days or less than two weeks.

- Reinforce of Meteorological Service (JICA)
- Numerical Weather Prediction (WMO/China)
- Hydro-Meteorology and GIS (WMO)
- Satellite Meteorology and Weather Forecast (Philippines)
- Producing High Resolution Climate Information (WMO/Korea)
- Meteorological Instrument and Calibration (Philippines)
- International Workshop on Climate data (WMO/China)

5) Implementation Plan for Weather Forecast of Meteorological Division

Operational weather forecast of Meteorological Division involves basic problems, such as the lack of Meteorological Information for analysis and the imperfect quality control of observational meteorological data.

In this Project, GTS/MSS and Satellite Data Receiving Equipment are introduced at NWFWC. This equipment and facilities contribute to get various meteorological information such as GPV data, hydro-Meteorological data and Satellite Image data. A Meteorological expert is dispatched to utilise this information. The TOR of the Meteorological expert was planned shown as follows.

- Developing systematic weather forecasting operation and conducting training based on the training materials

Training materials are made using the GPV data of GTS/MSS output. The JICA Expert conducts training using these materials. The JICA Expert reviews the new routine operation procedure to improve weather forecasting, weather advisory/warning and flood forecast. He also reviews data archiving system.

- Make up the Operation Manual of Weather Forecasting

The Operation Manual of Weather Forecasting is made in parallel with the above mentioned reviews of forecasting operation. This manual includes the assessment of the following items, such as archived data, procedure of forecasting, and standards of advisory/warning.

2) Preparation for the Training of SATAID

In this Project Japanese Meteorological Satellite data Receiving system and software named SATAID are installed. The SATAID is application software to display satellite imagery and Numerical Weather Prediction for weather analysis. To make effective use of this system, training for utilization technology of meteorological Satellite imagery is conducted in Japan and Bhutan. In November 2014, JICA conducted "the training for utilization technology on meteorological Satellite" in Japan.

3) Trainings for SATAID Utilization Technology in Japan and Bhutan

The training on the utilization technology of meteorological Satellite imagery SATAID for three forecasters in Meteorology Division of DHMS was implemented in Japan from 30 October to 7 November 2014.

The JICA Expert implemented the presentation for the purpose both of introduction of SATAID and necessary conditions for improvement of weather forecast utilizing SATAID, and of review of JICA training course for utilization of SATAID, for ten

staffs of Meteorology Division, DHMS on 25 May 2015.

On the same day, the JICA Expert installed the SATAID application with its automatic data acquisition software on the computer used at weather forecasting operation in the Division, and demonstrated the SATAID animation of cloud imagery and GPV data.

Practical training for utilization of SATAID for operational weather forecast has not been initiated because of the delay of installation schedule of GTS/MSS system at the NWFWC.

A C/P who had been trained in Japan made a presentation on the fruits of the JICA SATAID training for seven forecasters on 8 June 2015. The JICA Expert added supplemental explanation at the presentation.

4) Current Status and Issues on Weather Forecast in DHMS

The JICA Expert made inquiries on the current status, issues and views of the Weather Forecasting at the Meteorology Division into six forecasters on 26 May 2015. The results are shown below.

-Current status

After the submission of the Progress Report (1) in September 2014, the use of WRF (Weather Research and Forecasting Model) system which had been installed by support of Finland Meteorological Institute in May 2014 was routinized by making use of NOAA NWP Model through the Internet.

-Issues

Weather forecasting at the Division was started from 2007 with the help of JICA Senior Volunteer. But so far there is no professional with a concrete background of Meteorology in the Division. The head of the forecasting unit has a Bachelor’s Degree in Civil engineering with a Master’s in Applied Meteorology. Current weather forecasters (technicians) are trained in short term training in weather forecasting and analysis. All the weather forecasting works are done at technician level.

Beside that just now weather forecasting works are carried out by one desktop computer. There is also lack of technical problems in handling advanced technology such as satellite/data analysis software, proper model interpretation and validation by the forecaster.

In addition to daily works the forecasting unit is often facing problems with the internet connectivity specially while downloading, viewing WRF products, satellite data and other weather products.

-Views

Among the above Issues, less desktop computer and telecommunication problems except for internet connectivity is dissolved by introduction of the GTS/MSS system in the NWFWC.

The Meteorology Division has plans to do model interpretation and validation after developing human capacity under the backup of the JICA Project.

In addition, even though there is requirement of guidance for the model for which a working station is necessary along with the building of technical capacity to understand and handle such tools, the new GTS/MSS and the SATAID data received by Himawari Cast contribute to overcome these issues.

Since the Division has a WRF model for three days (72 hours) lead time forecast, the validation of the model is still required before actual operation. Under the five year plan to 2018, the Division would make it practicable utilizing the GTS/MSS system.

Besides, the Division has a plan to set up a weather studio in the NWFWC for which the forecaster will present the weather forecast on the display, and information will be made available to the media.

-Other Subjects

A thunderstorm associated with windstorm is common in most parts of the country during the pre-monsoon and post monsoon season. Most frequent windstorms occur in the southern and eastern parts of the country. The Division currently lacks in providing such forecast due to lack of the proper idea on wind forecast knowledge for terrain like Bhutan.

There are many models available from the websites as well from the WRF model run by Division but these have not been available because of the accuracy over Bhutan countryside.

The Division is in need of other training from experts if they can train the forecasters on how to carry out the wind forecast over the Himalayan country, so that the forecast of wind is effective for early warning to the general public for preparedness in time.

5) Preparation of Training Material and Implementation of Training on GPV Data Utilization

(1) Preparation of Draft Training Material

The JICA Expert prepared the training manual for basic utilization of the GPV (Grid Point Value) data which were the products of the Numerical Weather Prediction (NWP).

The operational training manual on the GPV data utilization specified for the GTS/MSS system at the NWFWC is prepared in the second year (after October 2015) of the Project because of the delay of installation schedule of the GTS/MSS system. The draft table of contents of the material is as follows.

Table of Contents of Training Material for GPV Data Utilization (Draft)

1. Basic knowledge of numerical weather prediction (NWP)
    1.1. Outline
    1.2. Observation data and quality control
    1.3. Data assimilation
    1.4. NWP model
    1.5. Application
2. The latest NWP system
    2.1. Outline
    2.2. The latest improvement

(2) Implementation of the Training

The JICA Expert implemented basic training of the utilization techniques of GPV using the manual noted at 1) for six forecasters in the Meteorology Division on 30 June 2015.

The operational trainings utilizing the actual GPV data received through the GTS/MSS system at the NWFWC is implemented in the second year (after October 2015) of the Project because of the delay of installation schedule of the system.

6) Preparation of Weather and Flood Forecasting Manual and Implementation of Training

(1) Preparation of Draft Manual

The JICA Expert prepared a draft weather and flood forecasting manual utilizing SATAID and GPV data to be used at the NWFWC in cooperation with three C/Ps who had been trained in Japan in November 2014.

However, detailed parts of the Manual especially related to the utilization of GPV data received through the GTS/MSS system have not been described yet because of the delay of installation schedule of the System at the NWFWC.

The operational forecasting manual is completed in the 2nd Phase (after September 2015). The table of contents of the draft manual is as follows:

Table of contents of weather and flood forecasting manual (DRAFT)

1. Introduction
    - 1.1. Explanation of contents
    - 1.2. Outline of the analysis and forecast
    - 1.3. Weather Information
2. Weather chart analysis
    - 2.1. Surface weather chart analysis
    - 2.2. Landform affection and analysis
    - 2.3. Upper weather chart analysis
3. Grasp atmospheric structure
    - 3.1. Recognition of feature of pattern
    - 3.2. Jet stream
    - 3.3. Vertical structure of disturbance
    - 3.4. Water vapor mass
4. Prediction of change
    - 4.1. Prediction of pattern
    - 4.2. Prediction of disturbance
    - 4.3. Prediction of water vapor mass
5. Translation to weather forecast
    - 5.1. Order of translation
    - 5.2. Clear weather
    - 5.3. Rain
    - 5.4. Snow
    - 5.5. Translation to wind and temperature
6. Forecast for rainfall
    - 6.1. Forecast for beginning and end of rainfall
    - 6.2. Forecast for peak of rainfall
    - 6.3. Forecast for rainfall amount in short range and long range
7. Forecast for snowfall
    - 7.1. Forecast for beginning and end of snowfall
    - 7.2. Forecast for depth of snowfall
8. Forecast for temperature
    - 8.1. Maximum temperature
    - 8.2. Minimum temperature
9. Forecast for wind
    - 9.1. Landform affection and analysis
10. Weather information and advisory/warning
    - 10.1. Procedure and contents of these information

(2) Implementation of Training

The JICA Expert implemented the operational trainings of weather forecast for the C/Ps in the forecast unit, Meteorology Division, DHMS as written bellow. These trainings are, however, even partially completed by the delay of the installation schedule of the GTS/MSS as written in 1).

- Consultation on the assignment for preparation work of the draft manual (9 June 2015: with three C/Ps)
- Explanation on how to use the SATAID for each forecast element (12 June 2015: with three C/Ps)
- Explanation on the outline of meteorological data which is displayed at the GTS/MSS (18 June 2015: with two C/Ps)
- Coordination on the rotating schedule for weather forecasting operation at the NWFWC(22 June 2015: with two C/Ps)
- Coordination on the future operation system of 22 AWS stations (ditto)
- Consultation on the future observation including observing elements at Class A stations (24 June 2015: with two C/Ps)

3.3 Achievements on Output 2 Activities

All the Project achievements on Output 2 "Early Warning System (EWS) for GLOF/rainstorm are developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu" in the 1st Phase (September 2013 - July 2015) are described in this section.

3.3.1 Current Condition and Issue on Existing Meteorological and Hydrological Observation Network and Hydropower Plant (Activity 2-1)

1) Present Situation and Task of Meteorological and Hydrological Network in Target Basins

(1) Hydrological Observation Network

The hydrological observation network in Bhutan is shown in Figure 3.1. The hydrological observation network covers the lower basins of Mangdechhu and Chamkharchhu Basins but it is recommended that the network be expanded upstream for flood warning to upper and middle parts of the basins including the Mangdechhu Dam under construction. Hydrological observation facilities are installed in the upper basins in the Project.

(2) Meteorological Observation Network

The meteorological network in Bhutan is shown in Figure 3.2. As stated in chapter 3.2.1, it is recommended to begin meteorological observation in mountainous areas because these areas are lacking in meteorological observation.

Table 3.14 shows the annual rainfall at Bjizam and Chamkhar, the northernmost station in Mangdechhu and Chamkharchhu Basins, and specific discharge (= annual total discharge / area of catchment) of nearby hydrological stations in both basins. The following equation is formed in a basin;

Rainfall = Surface Discharge + Actual Evapotranspiration + Subsurface Discharge.

The surface discharge in the above equation corresponds to the specific discharge. The specific discharge must be less than the rainfall. As shown in the tables, the specific discharge is more than the rainfall, and the ratio is huge, such as 170% or 138% in Mangdechhu or Chamkharchhu Basin.

Table 3.14 Annual Rainfall and Specific Discharge

Mangdechhu river basin

Year	Rainfall (at Bjizam, mm)	Specific Discharge (at Bjizam, mm)	Specific Discharge / Rainfall
1996	1019	1631	160%
1997	1406	1416	101%
1998	1291	1799	139%
1999	1301	1489	114%
2000	1082	1673	155%
2001	1167	1475	126%
2002	994	1307	131%
2003	1037	1552	150%
2004	1138	1535	135%
2005	892	1379	155%
2006	1023	1279	125%
2007	1014	1383	136%
2008	1043	1396	134%
2009	1116	-	-
2010	1158	1676	145%
2011	996	1323	133%
2012	827	1359	164%
Mean	1088	1479	138%

Chamkharchhu river basin

Year	Rainfall (at Chamkhar, mm)	Specific Discharge (at Kurjey, mm)	Specific Discharge / Rainfall
1996	889	1410	159%
1997	872	1248	143%
1998	815	1437	176%
1999	845	1311	155%
2000	687	1330	194%
2001	732	1195	163%
2002	723	1159	160%
2003	598	1242	208%
2004	874	1334	153%
2005	649	1163	179%
2006	780	1215	156%
2007	738	1215	165%
2008	813	1290	159%
2009	712	1209	170%
2010	841	1421	169%
2011	680	1224	180%
2012	587	1170	199%
Mean	755	1269	170%

Annual rainfall at meteorological stations in Mangdechhu and Chamkharchhu Basins are shown in Figure 3.16 and the elevations of these stations are shown in Figure 3.17. The rainfall at Bjizam and Chamkhar are referred to in Table 3.14 and their annual rainfall and elevation are respectively 1095 mm and 1840 m, 767 mm and 2470 m. The rainfall a little west of Bjizam with the elevation of 2660 m is 1497 mm, around 1.4 times of Bjizam's. The rainfall a little east of Chamkhar with the elevation of 3090 m is 1533 mm, around two times of Chamkhar's. Much more rain falls in the northern area with higher elevation but it cannot be detected because there is no station in the area.

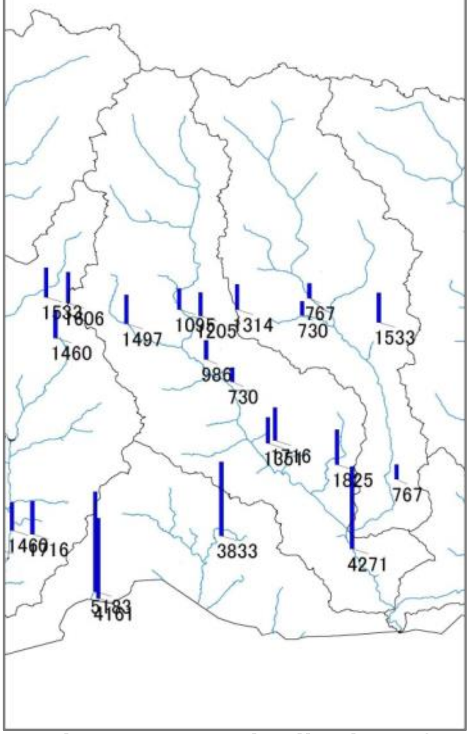


Figure 3.16 Distribution of Annual Rainfall (mm)

Red numbers locate at the station to be installed in this Project.

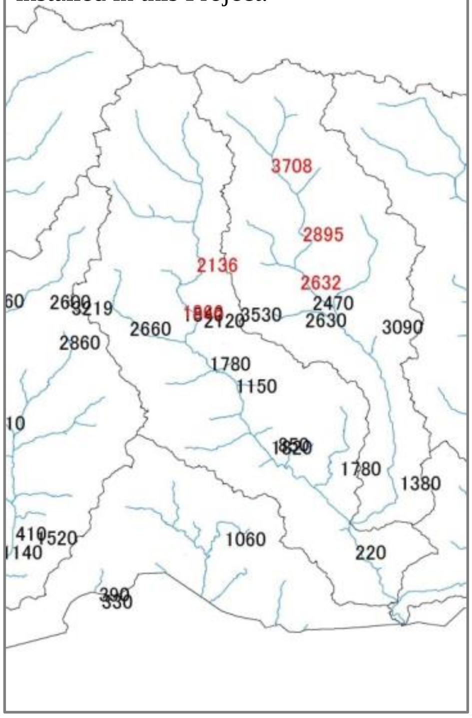


Figure 3.17 Elevation of Meteorological Stations (m)

This Project will begin rainfall observation at the stations denoted by the elevation with red numbers in Figure 3.17 and it is expected to provide more accurate rainfall in the basins. The installation and maintenance of the stations in high mountainous areas is difficult. It is recommended to make a future observation plan in the mountainous areas after the evaluation of data at the station installed in the Project as well as evaluating the difficulty of installation and maintenance. It is necessary to take into account the absolute deficit of rainfall when flow analysis is conducted based on the observed rainfall data.

2) Review of Dam Operation of Hydropower Projects

Hydropower projects construction are underway in both pilot basins of Mangdechhu and Chamkharchhu (refer to Figure 3.18). The construction of hydropower dam and other infrastructures have been started in the Mangdechhu, and the access road to the dam site of Chamkharchhu-I Hydropower Project is under construction at the moment. The EWS will be beneficial for the both hydropower plants during and after the construction, the project involves them as stakeholders.

DHMS have been coordinating between the project and Mangdechhu Hydroelectric Power Authority (MHPA). In fact, the control room of EWS of Mangdechhu basin is allocated in the MHPA dam colony, so that the EWS instruments will be well maintained by Bhutanese side. The MHPA will be dissolved after the construction and the all facilities and operational responsibilities will be relegated to Druk Green Power Corporation (DGPC).

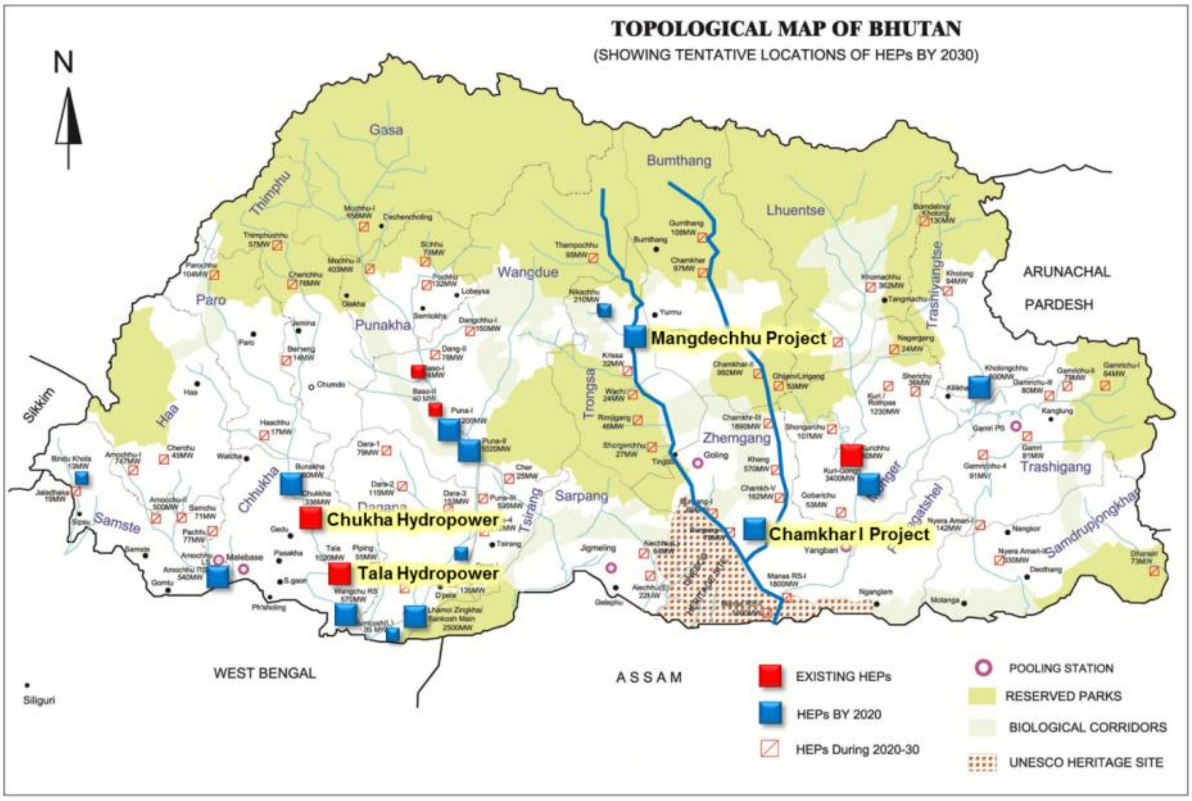


Figure 3.18 Tentative Location of Hydropower Project Sites by 2030

(1) Outline of Hydropower Project in the Target Basins

Salient features of Mangdechhu and Chamkharchhu-I Hydropower Projects are shown in Table 3.15.

Both hydropower projects are “Run-of-the-river-scheme”, where the intake dam is located about several tens kilometres from the power plant inside ground. Only dam facility exposed on the ground has the risk for rainstorm flood and GLOF.

The design flood discharge of Mangdechhu Hydropower Project is 8,500 cumecs including 3,700 cumecs of GLOF discharge estimated from the outburst of the Metatshota Lake, the largest glacial lake in the basin. On the other hand, the design flood discharge of Chamkharchhu-I Hydropower Project is 14,474 cumecs including 5,068 cumecs of GLOF discharge estimated from the outburst of the Chubda Lake, the largest glacial lake in the basin.

The Detailed Project Report of both projects recommended developing the following measures to enable operation of the spillway commence, avoiding overtopping the spillway against GLOF;

- Detecting system: water level measured 10-15 km upstream of the dam
- Data transmission system
- Warning system

The Mangdechhu Hydropower Project dispatches two observers to the hydrological station at Bjizam about 10 km upstream of the dam site to monitor 24 hours water stage of the river during construction phase. The project will install automatic gauging stations into Bjizam as well as further 19 km upstream of Bjizam to obtain longer lead time for the safe operation of the dam.

Table 3.15 Salient Features of Mangdechhu and Chamkharchhu-I Hydropower Projects

	Mangdechhu HP	Chamkharchhu-I HP
Basin	Mangdechhu	Chamkharchhu
Dzongkhag	Trongsa	Zhemgang
Catchment Area (km2)	1506	2891
Type of Dam	Concrete Gravity Dam	Concrete Gravity Dam
Dam Top level	EL 1,750.0 m	EL 858.0 m
Riverbed Elevation at dam site	EL 1,694.0 m	±EL 777.0 m
Dam height above river bed	56.0 m	±81.0 m
Length of Dam at top	141.0 m	149.5 m
Probable Maximum Flood	6,220 cumecs	9,406 cumecs
Standard Project Flood	4,715 cumecs	6,889 cumecs
GLOF	3,715 cumecs	5,068 cumecs
Design Flood	8,500 cumecs	14,474 cumecs
Full Reservoir Level (FRL)	EL 1747	EL 855
Mini Draw Down Level (MDDL)	EL 1730.5	EL 848
No.s of bays	4 Nos (including one standby)	5 Nos (including one standby)
Crest of Spillway	EL 1702.0 m	EL 810.0 m
Installed capacity	720MW (4 x 180 MW)	770MW (4 x 192.5 MW)
Total cost	Nu. 36,572.60 million (2008)	Nu. 69,328.62 million (2011)

(2) Operation and Management for Floods

Regulations and manuals of dam operation for the flood event will be formulated by DGPC after transfer of business. So far no manual has been prepared at both hydropower projects. Therefore, the regulations and manuals of the existing hydropower projects of Chukha and Tala, both located along the Wangchhu River in the western Bhutan, were collected from Department of Hydropower and Power System (DGPC), DGPC and the hydropower offices. Although the both dams have regulations and manuals on water level manipulation for power generation or safety of dam facility, they have no function and capacity for flood control.

Chukha Hydropower Project

Chukha Hydropower Project (336 MW) is the oldest hydropower plant in Bhutan, which started operation in 1988. During the flood season, water stage observers are dispatched to Chuzom, 25 km upstream of the intake dam. They report hourly stages to the dam operation office and the power plant. The operation procedure during flood is regulated in detail based on the water stage at Chuzom. When the discharge at Chuzom exceeds 700 cumecs, the plant stops to generate and releases the water by full opening of the gates. In fact, during Cyclone Aila in 2009, the maximum discharge rose to 2,000 cumecs, then the plant shut down the intake and the power generation. The maximum speed of gate opening is about 0.33 m/min, equal to 57 minutes to fully open the 19m height gates.

Tala Hydropower Project

Tala Hydropower Project (1,020 MW) is the largest hydropower plan and started operation in 2007. The intake dam is located at just downstream of the Chukha Power Plant. So the dam gates are operated under close communication with the Chukha Hydropower Project. Since the intake elevation of Tala is higher than the one of Chukha, the damage by silting into the headrace tunnel is less. So the Tala hydropower plat was continuously operated even during Cyclone Aila in 2009. The maximum speed of gate opening is about 0.5 m/min, equal to 26 minutes to fully open the 13m height gates.

(3) Emergency Action Plan

DGPC has formulated an “Emergency Action Plan (EAP)” combining both Chukha and Tala Hydropower Projects. The draft plan has already been completed and will be revised based on the mock drills that will be conducted in 2014. The purpose of EAP is to regulate the emergency action of “Emergency Response Teams (ERTs)” organized in both hydropower project offices, during the abnormal discharge derived from heavy rainfall and/or GLOF. The actual actions regulated in the EAP are summarized in Table 3.16.

It is expected that the EAP will be formulated at Mangdechhu and Chamkharchhu-I Hydropower Projects as well. The SOP on flood early warning in the project could be basic information to formulated EAP in future.

Table 3.16 Emergency Event Level and Action to be Taken in EAP

Description of item	Event Level	Action to be taken
If the river inflow is less than 600 m^3/s	**Normal**	No action is required. However, the plant operators at Dam and in Power House must be alert and monitor the condition for further development of the risk.
If the river inflow is between 600 to 2000 m^3/s	**Alert**	Reservoir level shall be maintained between EL. 1838.oo and EL. 1339.00. The head dam unit and Shift In charge, Dam control room shall asses the condition at dam coordinate with In charge control room for regulation of load.
If the river inflow above 2000 m^3/s and still in rising trend	**Emergency**	Shift In charge, dam control room shall inform the In charge Power House for total shutdown of generating units. SCE shall confirm the approval from the competent authority before taking the total shutdown of power house. Follow the shutdown procedure

3.3.2 Hydrological Information Collection and Analysis for EWS Designing (Activity 2-2)

1) Field Inspection

Field inspection into the pilot basins has been conducted according to y the schedule shown in Table 3.17. During the inspection, Dzongkhag officers accompanied with DHMS staffs to allocate appropriate lands for the instruments. Several additional inspections have been conducted to prepare detailed specifications and installation plans.

Table 3.17 Field Inspection Schedule

Date		Works
20 October 2013	Sun	Move (Thimphu to Trongsa) stopping at Wangdue FEW Station
21 October 2013	Mon	Site Inspection at Bjizam / Meeting with MHPA / Visit Trongsa AWS
22 October 2013	Tue	Site inspection at Jongthang
23 October 2013	Wed	Site inspection at Jongthang / Site Inspection at Tingtibi, Zhemgang
24 October 2013	Thu	Kick-off Meeting in Trongsa City Hall / Mover (Trongsa to Bumthang)
25 October 2013	Fri	Courtesy to Jakhar Dzong / Site Inspection at Kurjey
26 October 2013	Sat	Site Inspection at Chokkhortoe and Kagthang
27 October 2013	Sun	Site Inspection in the Bumthang valley
28 October 2013	Mon	Kick-off Meeting in Jakhar Dzong
29 October 2013	Tue	Site Inspection at Tsampa (Trekking)
30 October 2013	Wed	Site Inspection at Tsampa (Trekking)
31 October 2013	Thu	Site Inspection at Tsampa (Trekking)
01 November 2013	Fri	Site Inspection at Tsampa (Trekking)
02 November 2013	Sat	Site Inspection at Tsampa (Trekking)
03 November 2013	Sun	Move (Bumthang to Thimphu)

2) Evaluation of Existing Observation Instruments and GLOF EWS

(1) Evaluation of Existing Observation Instruments

i) Evaluation of AWLS

Bubble gauges used in real time AWLS have been confirmed as the suitable water level gauges of the rivers in Bhutan.

The installation and observation of real time AWLS were checked with the following schedule with the C/P of DHMS and the stored data were investigated for the evaluation of existing observation instruments.

- Stopped laser–type gauge at Yebesa on Mochhu AWLS on 20 Oct. 2013
- Bubble gauge on Zhemgang on Mangdechhu AWLS on 23 Oct. 2013
- Bubble gauge on Dangsa on Phochhu AWLS on 7 Nov. 2013
- Installation of bubble gauge at Yebesa on Mochhu AWLS on 7 Dec. 2013

The characteristics of the rivers in Bhutan are rapid flow, plenty of suspension of solids in river water and no artificial banks. Water level gauges installed in this Project need to be suitable to meet the above circumstances.

Float, pressure gauge, bubble and laser are the sensors or the type of water level measurement on rivers. The float-type is not suitable for rapid flow river or along natural banks because it needs a stilling well at high cost and is difficult to install. Pressure sensors had been installed by DHMS but were removed because of the difficulty in keeping out clogging of pressure sensors. A laser-type was installed at AWLS of Yebesa on Mochhu in October 2010 but it stopped in April 2012 because of a malfunction and replaced with a bubble gauge in October 2013. Another laser-type also malfunctioned on the Tamchhu. The bubble gauge is a complicated instrument with a mechanism sending air to its orifice terminal all the time but it can prevent its orifice terminal from clogging. It is suitable for a river with plenty of suspension solids. Bubble gauges are used at almost all AWLS of DHMS with little trouble. There was some trouble with icing that clogged the orifice terminal at the cold stations with high elevation.

ii) Evaluation of AWS

Compact weather sensor (CWS) and balance principle rain gauge (BPRG) used in real time AWS at Hongtsho are confirmed as suitable weather sensors for observation in the cold area of Bhutan.

The installation and observation of real time AWS at Chamkhar, Dangsa, Simtokh and Hongtsho were checked in October and November 2013 with the C/P of DHMS and the stored data were investigated for evaluation of existing observation instruments.

An AWS is installed at Tsampa in the Project and CWS is installed at four AWLS sites. These sites are in cold regions and weather sensors are needed to observe not only rainfall but also snowfall at the sites. Sensors capable of observing snowfall in Bhutan are CWS and BPRG at Hongtsho and Korilla and another type of BPRG at Thanza. The BPRG at Thanza recorded erroneous data and is not a suitable instrument. Figure 3.19 shows the cumulative precipitation of CWS and BPRG from May 2012 to November 2013 at Hongtsho and Korilla. Cumulative rainfall and snowfall amounts in winter of two sensors are almost the same and these sensors are considered to be suitable for the precipitation observation throughout the year.

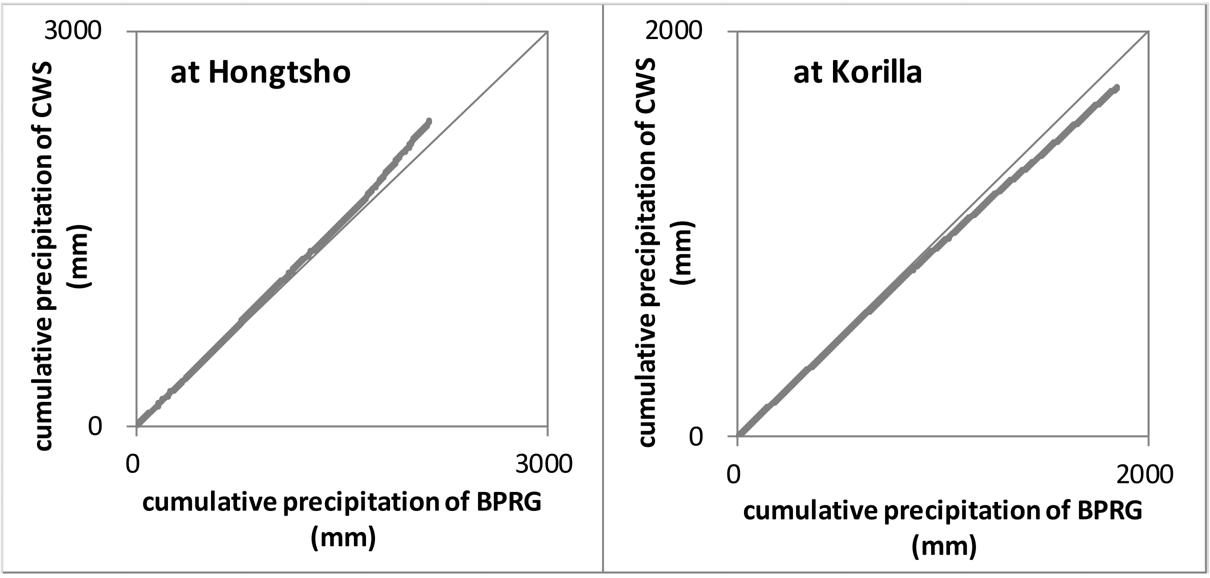


Figure 3.19 Comparison of Precipitation Amounts of CWS and BPRG at Hongtsho and Korilla

(2) Evaluation of GLOF EWS

Site visits of observation facilities in the Punakha-Wangdue Valley, Control Room at Wangdue, understanding SOP and the actual operating situation were investigated and the present GLOF EWS is confirmed as a satisfactory system.

GLOF EWS began with the installation of six AWLS, two AWS in Phochhu and 17 warning sirens along the Punakha-Wangdue Valley in 2011. Data and warnings are transmitted by Iridium satellite communication. GLOF EWS was expanded to the Mochhu Basin with the installation of an AWLS, an AWS and siren as well as the upgrade of an AWLS. Another AWLS will be installed by September 2014. An SOP of GLOF EWS was published in 2012 and it was revised in 2014 with the expansion of the network.

A flood occurred on the Mochhu on 15 and 16 July 2014 and it reached above the alarm level. A meeting was called in accordance with the procedure of the SOP. The meeting collected other information and estimated that the flood would not reach the downstream. GLOF EWS is operated as mentioned above.

The following problems concerning the observation system were reported;

- Warning sirens were activated by a false rise in water level caused by the icing in the orifice terminal.
- The total precipitation gauge did not record the correct precipitation.
- High expense of the Iridium satellite communication

The present GLOF EWS is designed for a flood caused by GLOF and it provides qualitative warning of a flood. An old bridge was washed away in Wangdue by the flood caused by the rainstorm in 1968. This basin needs a flood warning and forecasting system for not only GLOF but also rainstorms. It is recommended to improve the EWS which can be applied to a flood caused by rainstorm and provide quantitative flood warning.

3.3.3 Design of Location and Specification of EWS (Activity 2-3)

1) Outline of EWS

According to the discussion between JICA side and Bhutan side, the outline of entire system of EWS developed in the project is shown in Figure 3.20. The system is comprised of monitoring and forecasting system of NWFWC in Thimphu (TMP) and early warning systems installed into the Mangdechhu basin (MND) and Chamkharchhu basin (CHM).

The system installed into NWFWC receives necessary hydro-metrological information from in / outside of Bhutan, and forecasts precipitation and floods. The information is also transferred to the pilot basins via internet and radio communication. The system installed into the basins is composed of 1) automatic hydro-meteorological observation stations (AWS/AWLS), 2) Control room which integrates data from observation stations and 3) Siren Towers to warn the floods to the residents. The early warning system has to be a “closed system” in the basin, which should not depends on landlines and/or any other system outside of the basin. Based on this concept, all facilities in the basin is connected by HF radio communications each other. Moreover, one radio system is installed into the Dzong, so that local broad casting can be done from the Dzong to the residential area not only in the emergency case but also in the normal condition.

The observed data collected by the observation stations in the basins are sent to a meteorological satellite of METEOSAT in addition to HF communication network. The received data by METEOSAT is then transferred to NWFWC in Thimphu via GTS network. This could be a backup system for the entire communication system.

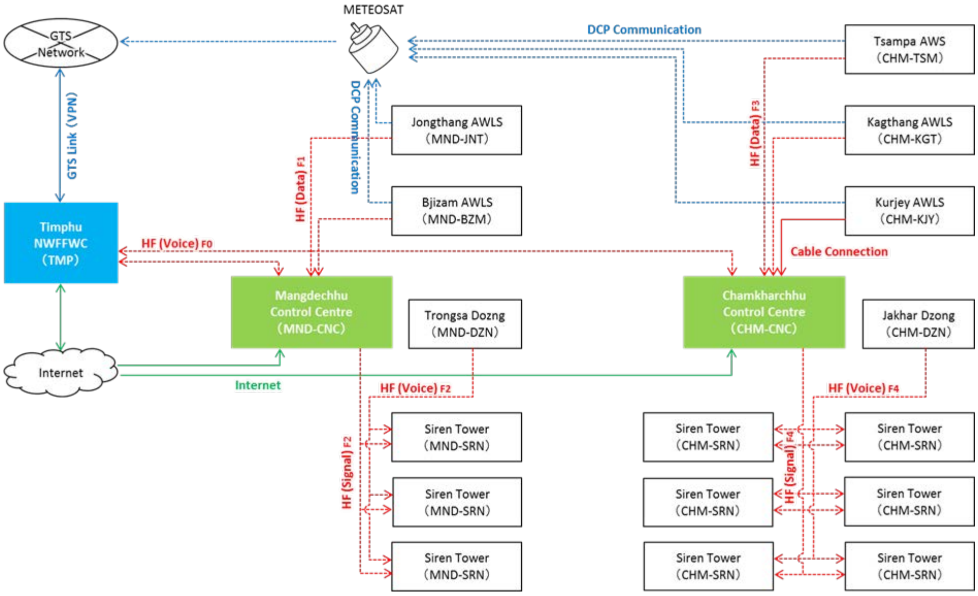


Figure 3.20 Enter System of GLOF and Rainstorm Flood EWS

2) AWLS and AWS

i) Sites of AWLS and AWS

A site inspection of new or upgrading AWS and AWLS was made at Bjizam, Jongthang, Kurjey, Kagthang and Tsampa with C/P of DHMS on 1-3 and 24-29 November 2013. The locations of AWS and AWLS were finalized and a simplified survey was made for the installation of observation facilities. DHMS requested the site of Jongthang AWLS to be relocated upstream in order to extend the lead time of floods to Mangdechhu Dam and a site inspection was made on 4-6 February 2014 again. The appropriate site was found about 5 km upstream of the old site at Mangdechhu and it can extend 15 minutes of the lead time of floods to the dam.

A simplified survey of the river was made around the newly installed hydrological stations of Tsampa, Jongthang and Kagthang to develop the rating-curve with the C/P of DHMS on 24 and 26 May, 10 June 2014 respectively. The rating-curves were developed based on the indirect measurement method (Measurement of Peak Discharge by the Slope-Area Method, Techniques of Water-Resources investigations of the United States Geological Survey, Chapter A2, 1984) and are shown in Figure 3.21. Gauge heights refer to the arbitrarily reference marks.

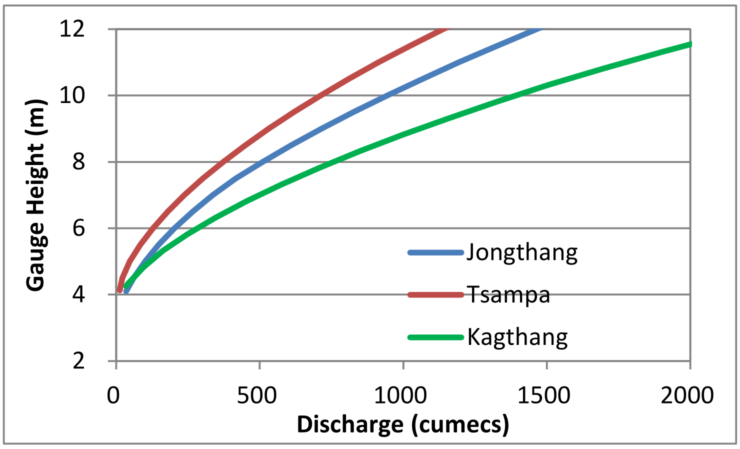


Figure 3.21 Rating-Curve of Newly Installed Hydrological Stations

(2) Specification of AWLS and AWS

i) Specification of AWLS

AWLS sites were located for suitable river water level measurement at Bjizam, Jongthang, Kurjey and Kagthang. The bubble gauge, which had been used as the sensor in real time AWLS in DHMS, was selected as the water level sensor because of easy maintenance and little trouble while used in Bhutan.

AWLS sites are in narrow slopes surrounded with trees. CWS was selected as the meteorological sensor because it can be installed in a narrow area.

ii) Specification of AWS

AWS is installed at Tsampa. Tsampa is located in a cold area with high elevation and is suitable for meteorological observation with flat land and no trees. It becomes an important meteorological station because its location is in a meteorological observation gap, as mentioned in Chapters 3.2.1 and 3.3.1. General surface meteorological instruments are installed at Tsampa as well as a water level sensor.

A balance principle rain gauge (BPRG) was selected because it can observe the amount of not only rainfall but also snowfall. The water storage bucket of BPRG needs to be emptied manually before cumulative precipitation reaches a certain value. A tipping bucket rain gauge is installed for the backup of BPRG. The bubble gauge is installed but trouble of clogging the orifice terminal due to icing was reported. Therefore a bubble gauge with a water temperature sensor was selected because it can provide the temperature environment of the bubble gauge.

3) Telecommunication System

The field surveys, to make certain of the location of observation stations, were conducted in the river basin of Mangdechhu and Chamkharchhu, during 20/OCT. ~ 3/Nov. and 24/Nov. ~29/Nov. 2013.

As for the DCP, the Japanese Meteorological Satellite could not be observed from the planned 3 observation stations. However the European Meteorological Satellite (METEOSAT) was in sight. In addition, DHMS wishes to use METEOSAT's Alert system. In this Alert system, DCP transmits short messages when the value of one or more measured parameters exceeds a pre-set threshold. For such reasons, the METEOSAT DCP system is employed as the observational data relay system of EWS. C/P and expert are studying technical information about EUMETSAT DCP system and are consulting with EUMETSAT.

As for the HF communication system, the technical specifications were prepared, based on the field survey, the result of communication simulation and propagation test. The propagation test is explained in section 3.3.3.

On 14 February 2014, DHMS and BICMA discussed on the frequency assignment of HF and VHF required for the Project. Table 3.18 shows the planned frequency allocation of the EWS. DHMS plans to use the HF band at Tsampa observation station which is near the Royal Bhutan Army (RBA) base. BICMA advised DHMS to confirm that RBA has no objection to the planned HF band. DHMS follows up and discusses this matter with BICMA and RBA.

C/P and experts of the Project consult with BICMA, EUMETSAT and RBA.

Table 3.18 Planned Frequency Allocation of the EWS

Type	Previous required frequencies by DHMS	Band plan proposed by BICMA	Allocated frequencies by BICMA in Feb. 2014	Revised required frequency by DHMS	Number of new frequencies	Remarks
HF	3500-7900KHz	3700-4200KHz	4050KHz	3000 - 4200KHz	1	1) Please allocate 2 frequencies which RBA* is not in use (refer to RBA's letter to DHMS). 2) DHMS would like to use 4050KHz for night time communication if still available.
		4400-4500KH	4405KHz	4400 - 4500KHz	1	
		7075-7145KHz	7100KHz	Cancel	-	RBA is already in use.
		7850-7900KHz	7870KHz	Cancel	-	RBA is already in use.
	-	-	-	9000 -10000KHz	1	
	29.7-30.0MHz	29.9-30.0MHz	29.95MHz	28.0-30.0 MHz	3	(29.95MHz was allocated)
UHF	402.0355-402.2005MHz	402-403MHz	402.1000MHz	402.0355 -402.2005MHz	2	1) Revised required frequency is still under review between DHMS and EUMETSAT official in charge. 2) DHMS will request 2 frequencies upon the review has been completed.
	-	-	-	Order of priority 1. 450 - 470MHz 2. 470 - 512MHz	1	This frequency will be used as a substitute for Wireless LAN.

*RBA: Royal Bhutan Army

4) Flood Warning Siren Tower

The proposed installation sites for flood warning siren towers (three in Mangdechhu and six in Chamkharchhu) were identified and determined with DHMS C/P through the field reconnaissance and the discussion with local stakeholders on November 24 to 28, 2013. The outline of the proposed sites are shown in Table 3.19.

Then, DHMS started required formalities for land allocation for proposed sites to district land allocation committee and NLCS after December 2013. DHMS C/P again discussed with the district land lease committee on March 3 - 4, 2014. DHMS practically completed all the land allocation by May 2014.

Table 3.19 Proposed Installation Sites of Flood Warning Siren Towers

Mangdechhu Basin

No.	Name of Siren Towers	Location of Installation Sites				Local Focal Person Discussed	
		Description	Land Classification	Latitude	Longitude	Name	Organization & Position
1	Bjizam Village	Grounds of Bjizam Primary School	Government land (School grounds)	27°31'20.35"N	90°27'29.32"E	Mr. Sonam Tobgyel Mr. Kinzang	Principal of the School Dzongkhag Education Officer
2	Dam Site	Left bank next to the dam crest (under construction)	Grounds of MHPA	-	-	Mr. Karma Chhophel	Chief engineer of Mangdechhu Hydroelectric Project Authority
3	Power Plant	Grounds of the power plant (under construction)	Grounds of MHPA	-	-	Mr. Karma Chhophel	Chief engineer of Mangdechhu Hydroelectric Project Authority

Chamkharchhu Basin

No.	Name of Siren Towers	Location of Installation Sites				Local Focal Person Discussed	
		Description	Land Classification	Latitude	Longitude	Name	Organization & Position
1	Choekhor Toe Primary School	Higher ground in the school grounds	Government land (School grounds)	27°40'28.00"N	90°44'06.06"E	Mr. Pema Thinley Mr. Taw Tshering	Off. Principal of the School Principal of the School
2	Kurjey Village	Above proposed AWLS on the left bank	Government land	27°35'34.57"N	90°44'06.06"E	Mr. Tashi Wangdi	Mang Ap of Choekhor Gewog
3	Wangdicholing Village	Grounds of Wangdicholing General Hospital	Government land (Hospital grounds)	27°33'33.30"N	90°44'41.02"E	Mr. Namgyal Dorji Mr. Pema Jamtsho	Health Administrative Officer Thueme of Chamkhar Thromde
4	Bumthang Downtown	Slope near town entrance gate	Government land	27°32'51.78"N	90°45'13.68"E	Mr. Pema Jamtsho	Thueme of Chamkhar Thromde
5	Gangrithang Primary School	Higher ground in the school grounds	Government land (School grounds)	27°32'54.90"N	90°45'34.17"E	Mr. Jamtho Mr. Pema Jamtsho	Principal of the School Thueme of Chamkhar Thromde
6	Gyelkhar Village	Big rock near the left bank of Chamkharchhu	Government land	27°32'13.68"N	90°45'42.30"E	Mr. Pema Jamtsho	Thueme of Chamkhar Thromde

5) Preparation of Draft Technical Specification for EWS

Draft Technical Specification for EWS was prepared based on the field inspection, hydrological condition and considering existing observation stations. The draft specification has been submitted to JCC meeting and agreed by JCC members on 7 February 2014.

6) Preparatory Construction Work for EWS (Local Subcontract)

(1) Background

Access to the sites of AWS and AWLS is difficult in the rainy season as well as rainfall time in the dry season. Construction works cannot be conducted in winter because of coldness. Therefore the period while construction works can be done is very short. The installation of the equipment may not be completed in the period, if the contractor procuring the equipment conducts fundamental construction such as felling trees, levelling the sites or constructing fencing. It is also difficult for the contractor to select an appropriate contractor and execute the management of the construction in the short period. Therefore the fundamental part of the construction work such as levelling, fencing and so on was conducted in the Project to avoid the delay risk of installing the equipment.

(2) Consideration of technical specification

The contents of the precursory construction works carried out by a subcontractor in the Project were decided on the reconstruction of the cableway shed at Bjizam and levelling and constructing fencing at the site of Jongthang, Kurjey, Kagthang and Tsampa. The technical specifications, drawings, bill of quantities and draft of the contract document were produced in cooperation with the C/P of DHMS after the field visit of the sites.

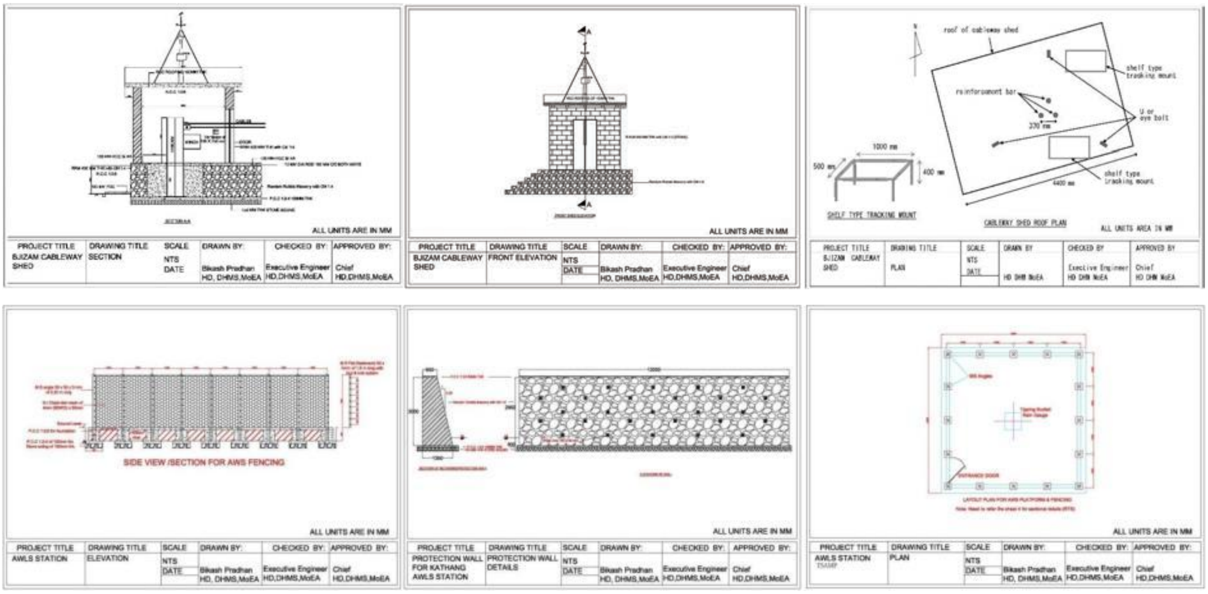


Figure 3.22 Some of the Drawings of Precursory Construction Works

(3) Local Subcontract

The submission of the quotation of the construction works was requested on 27 February 2014 to three possible contractors which had done similar works. The quotations were opened on 4 March and the contractor was decided on 6 March after contractual negotiation. The sites of the construction works were shown to the contractor and the works were confirmed by the contractor and C/P on 9-12 March. The procedure obtaining permission for felling trees was conducted in the same period. The contract was made on 28 March and the contractor began the construction works in the same day.

(4) Management of Construction Work

The management of the subcontractor's works was executed with the C/P of DHMS and the works were completed satisfactorily on 15 June 2014 within the contract period.

7) Field Test of Wireless Communication

The field test of 29.8 MHz HF wireless communication is used in the EWS of the Project was executed on 19 and 20 May 2014 with the cooperation of C/P of DHMS. The intensity of receiving radio waves was measured on three test paths selected based on the difficulty of wireless communication. The result was applied to the simulation of wireless communication and the technical specifications of HF radio set and its antennas were decided.

3.3.4 Installation of EWS Equipment into Pilot Basins (Activity 2-4)

All equipment for EWS is directory procured by JICA Headquarters via open tendering. The bidding has already been done on August 2014, five months delay from the original schedule. The detail procedure to prepare the tendering documents is shown in Table 3.20.

Table 3.20 Preparation of Tendering Documents

Date	Works
31 / 01 / 2014	Submission of 1st draft of specification forms for public announcement
25 / 02 / 2014	Teleconference with INTEM Consultant who contracted to prepare specification forms
07 / 03 / 2014	Meeting with INTEM Consultant to reassembling of the specification forms
14 / 03 / 2014	(Interrupt of specification preparation works)
22 / 04 / 2014	Submission of 2nd draft of reassembled specification forms
09 / 05 / 2014	Meeting with INTEM Consultant to recommence the preparation works
21 / 05 / 2014	Submission of 3rd draft of specification forms with some revisions of condition
04 / 06 / 2014	(Breakaway of INTEM from specification preparation works)
16 / 06 / 2014	Meeting with JICA office to accelerate specification preparation works
20 / 06 / 2014	Meeting with JICA HQ to confirm schedule of specification preparation works
04 / 07 / 2014	Meeting with JICA HQ to confirm inspection procedures
11 / 07 / 2014	Meeting with JICA HQ to confirm schedule of public announcement
14 / 07 / 2014	Finalization and submission of the speciation forms
18 / 07 / 2014	Public announcement

1) Supporting Preliminary Site Survey

Preliminary site survey by the JICA Contractor has been conducted in order to confirm the site condition and the radio communication as well as logistics for the installation in the period of September 28, 2014 to October 7, 2014. DHMS and the JICA Expert Team has worked together to obtain visa clearance and necessary permits for the Contractor. DHMS and the JICA Expert Team have also attended the entire period of the site survey shown in Table 3.21.

As a result of the radio communications test, most of the sites can receive enough radio intensities excepting the sites of Tsampa AWS in the Chamkharchhu river basin and Power Plant siren tower in the Mangdechhu river basin. Accordingly, the JICA Contractor proposed that Kagthang AWLS would have a "Store and Forward" function to relay the radio signal from the Tsampa AWS to the Kurjey control room, and the Power Plant siren tower would be installed on a hill at the some distance from the original planed location. DHMS and the JICA Expert Team have agreed to the proposal.

As for the radio communication tower planned to install into Trongsa District Office premises, special consideration is necessary due to the landscape conservation and the cultural importance of the Office Building (Dzong). Therefore, Trongsa District Office and DHMS have submitted an application for permission to install the radio communication antenna to the Ministry of Home and Cultural Affairs.

Meanwhile, the alternative solution that the antenna cable would be placed along beams in the roof space of the District Office without tower was examined.

Table 3.21 Schedule of Preliminary Site Survey

Date	Survey Contents
Oct. 7 – 8	Preparation of site survey
Oct. 9 – 15	Radio communication test and site survey in the Chamkharchhu river basin
Oct. 13 – 16	Visiting Trongsa District Office and Jakhar District Office for the radio installation
Oct. 17 – 20	Radio communication test and site survey in the Mangdechhu river basin
Oct. 21 – 24	Reporting of the site survey and discussion for radio frequency allocation

Radio Communication Test at Kagthang AWLS

Site Survey at Trongsa Dzong with the Governor

2) Pre-shipment Inspection

The JICA Expert Team has joined and supported the factory assembly test and the pre-shipment inspection as described in section 3.2.2.

3) Preparation before Arrival of Equipment

Prior to the arrival of the equipment, DHMS and the JICA Expert Team held a meeting with Mangdechhu Hydro Power Authorities (MHPA) on March 4, 2015, in order to confirm the progress of construction of the control room that has been delayed. MHPA proposed to provide alterative building in the Security Division & Fire Fighting Unit Office in the dam colony. Due to the radio communications incompatibility, however, it was agreed to use the other building of the Quality Control Laboratory instead. In addition, the site of the Power Plant siren tower has also been reconfirmed in the meeting.

4) Supporting AWLS and AWS Installation

The JICA contractor for the procurement and installation of equipment was supported to install hydrological and meteorological instruments in collaboration with the staff of DHMS. The instruction of locations, positions and settings of observation instruments were given to the JICA contractor on the following schedule (Figure 3.23 and Figure 3.24); Jongthang AWLS: 9-10 and 23-25 May, Bjizam AWLS: 11 and 26 May, Kagthang AWLS: 12 May, 5 and 10 June, Tsampa AWS: 15-18 and 29-30 May, Kurjey AWLS: 20 May, 4-9 and 13 June.

The operation of the observation instruments was checked at the sites after the installation. Furthermore the data transmission and their format were checked with the comparison of stored data in observation sites and received data by control rooms.

Jongthang AWLS

Bjizam AWLS

Water Level Station of Tsampa AWS

Meteorological Station of Tsampa AWS

Kagthang AWLS

Meteorological Station of Kurjey AWLS

Figure 3.23 Installed AWLS and AWS

Jongthang AWLS

Bjizam AWLS

Water Level Station at Tsampa AWS

Kagthang AWLS

Water Level Station at Kurjey AWLS

Figure 3.24 Installed Water Level Measurement Instruments at AWLS and AWS

5) Assisting Installation Works for NWFWC and Control Rooms

DHMS and the JICA expert assisted the JICA Contractor to conduct following installation work,

- 24, 25 April 2015: The HF antenna installation point was decided at NWFWC.
- 30, 31 April: The frequencies of radio communication, which would be used in the field observation sites, were coordinated between DHMS/JICA Contractor and BICMA.
- 7,8 June: Installation work of the monitoring PC and adjustment of the radio communication instrument were assisted at Mangdechhu Control room (MHPA Dam colony) .
- 9,10 June: Installation work of the monitoring PC and adjustment of the radio communication instrument were assisted at Chamkharchhu Control room (Kurjey). DHMS got Internet circuit open for action.

Installation work at Control room
(MHPA Dam Colony)


Layout of Control room
（Kurjey）

Adjustment of HF Antenna
(Kurjey)

Application for Internet Connection
(Bumthang)

6) Assisting Installation Work at Warning Siren Tower and District Offices

- 7, 8 June 2015: Installation work of Bjizam Siren Tower and adjustment of radio communication instrument were assisted in Mangdechhu basin.
- 9, 10 June: Installation work of 6 Siren Towers and adjustment of radio communication instrument were assisted in Chamkharchhu basin.

Siren Tower at Bjizam Village

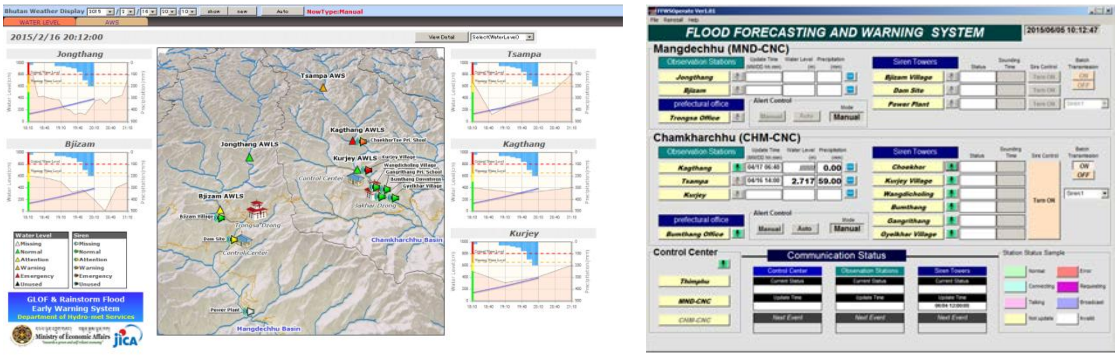
Siren Tower at Bumthang Downtown

7) Supporting Software Development

After the preliminary site survey, the JICA Expert Team and the JICA Contractor have continued to discuss user-interfaces for the system of the central operation center and control rooms in the basins in consideration of DHMS's requests. Accordingly, the main interfaces is divided into two (2) parts, one is "flood monitoring interface" showing graphs of water level, rainfall and meteorological observed data in the large screen, the other is "operation interface" to control sirens and radio communications.

A prototype of the software was prepared and explained to DHMS by the JICA Contractor at NWFWC on June 4, 2015. Because the communication scheme of the new system is rather complicated compering with the existing EWS in the Punatsangchhu river basin developed by SUTRON, USA, the user-interfaces are also cumbersome. So far, the full function of the prototype has been unable to be examined because the radio communications have not been established at the moment. Therefore, it was confirmed that DHMS and the JICA Expert Team would sort out the necessary modifications and request to JICA Contractor to modify the interfaces after establishment of the full radio communications.

The JICA Expert Team and JICA Contractor held a meeting in Tokyo on June 23, 2015, and concluded that the Contractor works for the modification and finalize it in September before OJT in the early October. The updated prototype EWS user-interfaces are shown in Figure 3.25.



Flood Monitoring Interface

Operation Interface

Figure 3.25 Prototype EWS User-interfaces

8) Setting Threshold of Water Level for Early Warning

The thresholds of the water level at each observation site have been discussed among DHMS and the JICA Expert Team. In consideration of coherency with the existing EWS in the Punatsangchhu river basin, the thresholds are comprised of 2 levels of "Alert" and "Alarm". When the water level rising to the Alert Level at any observation stations, beep sound will be generated in the control room. If the water level continues rising up to the Alarm Level, then the all sirens will be activated automatically (the sirens can be stopped by manual operation).

The control rooms and NWFWC should be alerted when the water level reaches to the Alert Level. In view point of sustainable operation of the system, the control room and NWFWC should be alerted at least once in a year. Therefore, the Alert Level shall be determined as the annual maximum flood, which is nearly equal to the 2 years probable flood. On the other hand, the Alarm Level shall be determined same or less discharge of Cyclone Aila in 2009 in consideration of actual flood damage by the cyclone.

Verification of the Threshold

The Bjizam and Kurjey sites already have the stage–discharge rating curve (H-Q curve). The H-Q curves of the other sites were prepared by using an indirect measurement method based on simply measured cross-sections at each site.

The Alert Level was determined according to the flood mark that is probably equal to the annual maximum flood level. In comparison with the 2 years probable floods estimated from the probability at Bjizam and Kurjey converted by catchment area, however, the 2 yeas probable flood water levels of Jongthang and Tsampa are slightly higher than the flood mark. Considering safety, the flood mark was adopted for the Alert Level.

The Alarm Level was tentatively determined as the same level with Cyclone Aila. The level of Jongthang, Tsampa and Kagthang were also estimated from water level at Bjizam and Kurjey converted by catchment area (refer to Table 3.22).

Table 3.22 Verification of the Thresholds at Each Site

Station	Flood Mark	2 Years Flood	Alert Level	Cyclone Aila	Alarm Level
Jongthang	5.6m	6.30m (235cms)	5.6m	7.98m (499cms)	7.9m
Bjizam	—	3.78m (303cms)	3.8m	5.00m (642cms)	5.0m
Tsampa	4.6～4.9m	5.34m (92cms)	4.9m	6.76m (240cms)	6.7m
Kagthang	5.4～5.8m	5.51m (153cms)	5.5m	6.82m (398cms)	6.8m
Kurjey	—	3.05m (225cms)	3.0m	4.13m (586cms)	4.1m

Due to the lack of data accumulation, each threshold has been tentative. The thresholds shall be examined based on the observation results after installation, and are updated to the system.

3.3.5 Preparation of Manual for EWS Operation and Maintenance and Training (Activity 2-5)

1) Preparation of EWS Operation and Maintenance Manual

(1) Counterparts in Charge

Counterparts in charge of this activity are the deputy project manager who is the responsible person of the activity, a civil engineer who has experience on the existing EWS installation work and maintenance, and the chief project manager who has experience on existing SOP preparation.

(2) Process of the Activity

Process of the activity is shown in Table 3.23.

Table 3.23 Activity Process on Preparation of EWS O&M Manual

Date			Activity	Contents	Participant / Executant
Day	Month	Year			
20	April	2015	Meeting	Work Policy, Schedule	1
21 30			Review	SOP, Operation Manual of Punatsangchhu EWS	-
1	May		Meeting	Work Policy, Site Inspection	2
3			Inspection	CR and AWLS of Punatsangchhu EWS	6
5 29			Writing Checking	SOP revised version Draft	2
1	June		Meeting	SOP should be shelved Contents of O/M Manual	3
4			Inspection	COS in Thimpu Interface, Siren Logic	6
7			Inspection	CNC, AWLS, SS in Trongsa Initial Adjustment Work	3
8			Inspection	CNC, AWLS, SS in Bhumtang Instlation of Bubbler	5
10 30			Writing Checking	O/M Manual for Mangdechhu and Chamkahrchhu	3

DHMS set a EWS against GLOF up in Punatsangchhu river basin funded by UNDP in 2011. And DHMS has operated and maintained the EWS since the completion. The existing EWS is a large scale system as 10 automatic water level stations (AWLS) and 18 siren stations (SS).

The project introduces the second case of EWS into Bhutan in the Mangdechhu and Chamkharchhu river basins. DHMS also handles the new EWS. The activity has to reflect the actual condition of the existing EWS and related documents into the operation and maintenance manual for the new EWS in order to DHMS can handle smoothly the new EWS making use of own experience on the existing EWS. It was agreed that the basic policy of the activity is as mentioned above at the meeting on 1st May 2015.

The related prime documents of operation and maintenance for the existing EWS are described as below;

1) Standard Operating Procedure (SOP) for the GLOF Early Warning System Installed along the Punakha-Wangdue Valley (Version2.0, April 2014); DHMS
2) Bhutan GLOF-Early Warning System Control room Software Version 2.0 Operator's Manual November, 2013; Sutron Corporation
3) Bhutan GLOF Early Warning System in the Punakha-Wangdi Valley Consisting of Stream Gauge Stations Hydromet Stations and Siren Stations; Sutron Corporation

DHMS compiled document 1) by itself as a rule book. The contents are an overview of GLOF and EWS, authority and responsibility of administrative organization, components of EWS, maintenance service, warning service, public information and education, duties and responsibilities for monitoring personnel. document 2) describes specifically operation of the system software. document 3) is a compiled instruction handbook for each module. Both of them are written by Sutron Corporation who manufactured and installed the system.

If the activity separately develops a new manual then the double standard makes the staff confused. The activity started to revise the existing SOP (document 1) into common applicable version for both of the existing and the new EWS in order to avoid confusion. According to the contract specification, the JICA Contractor has to provide an operation manual for the system software and the instruction handbooks for equipment. The activity intended to appropriate them for document 2) and 3).

The activity team visited the Wangdue Control room and the Yabesa AWLS of the existing EWS on 3rd May 2015 to figure out the actual operation and maintenance situation. It is confirmed that the situation is fairly good but there are no log books of operation and maintenance. Another point is that preventive maintenance is absent, actual maintenance is implemented only in case of malfunction.

An outline of the revised SOP draft based on the existing SOP has been completed by the end of May 2015. The activity team held a meeting on 1st June 2015 and it was agreed that the contents of the revised SOP draft shall be changed as described below

- The revised SOP draft includes administrative terms such as governing organization and budgetary procedures. However required output of the project is consistently the manual which has more limited contents as practical operation and maintenance for the new EWS. Therefore the contents shall be changed to equate the project required output as described below.
- Name of the output is not “SOP” but “Operation and Maintenance (O/M) Manual”.
- Targets are limited Mangdechhu and Chamkharchhu river basins.
- The contents shall be;
  - Basic knowledge that should be possessed by staff in the Control Room and NWFWC (river basin condition, flood characteristics, alarm water level, flood arrival time, hazard area).
  - Outline of installed EWS such as system configuration and communication detail (transmission interval, transmission scheme, voice message etc.)
  - Operation of monitoring and manipulation system (software)
  - Operator’s action under alert and alarm condition
  - Regular maintenance for equipment and sensors. Recording log books.

The O/M Manual has been drafted for June 2015 along the policy mentioned above.

The activity team implemented on-site inspection of installation and regulation work in the Mangdechhu and Chamkharchhu river basins by JICA Contractor with support of DHMS and JICA Experts on 7 and 8 June 2015. The activity team studied equipment of the new EWS and installation environment.

(3) Contents of the Draft Manual

Contents and progress of the O/M Manual are shown in Table 3.24. The manual for the Chamkharchhu basin has the same contents but endemic information. Chapter 5 has been blank because the software operating manual by the JICA contractor has been unfinished. The Manual is perfected in the second phase after submission of the contractor’s manual.

Table 3.24 Contents and Progress of EWS Operation and Maintenance Manual

OPERATION AND MAINTENANCE MANUAL FOR THE FLOOD EARLY WARNING SYSTEM (FEWS) THE MANGDECHHU FEWS DRAFT JUNE 2015						
Chapter		Section		Draft	Blank	Remark
1	Introduction	1.1	What is this Book	✓		
		1.2	Scope of this Book	✓		
2	Basic Knowledge	2.1	Flood	✓		
		2.2	Flood Countermeasure	✓		
		2.3	FEWS	✓		
3	Characteristics of the Mangdechhu Basin	3.1	Outline	✓		
		3.2	Glacial Lakes	✓		
		3.3	Probable Flood Discharge	✓		
		3.4	Flood Arrival Time	✓		
		3.5	Flood Prone Areas	✓		
		3.6	Dam and Power Plant	✓		
4	The System	4.1	Whole System	✓		
		4.2	FEWS	✓		
		4.3	Main Communication Way	✓		
		4.4	Equipment of Each Station		✓	Waiting manual by manufacturer
5	Operation of the System	5.1	Operation under Alarm		✓	Waiting manual by manufacturer
		5.3	Operation in Normal Condition		✓	
6	Warning Service	6.1	Warning Process	✓		
		6.2	In Case of GLOF	✓		
		6.3	in Case of RSF	✓		
		6.4	Information Sharing with NWFFWC	✓		
		6.5	False Alarm	✓		
7	Maintenance Service	7.1	Type of Maintenance and Unit in charge	✓		
		7.2	Daily Check	✓		
		7.3	Quarterly Maintenance	✓		
		7.4	Repair Work	✓		
		7.5	Spare Parts	✓		
		7.6	Tools and Equipment	✓		
8	Thereshold Water levels at the AWLSs	8.1	Principle	✓		
		8.2	Setup the Value	✓		
		8.3	Threshold Water Levels at Jongthang AWLS	✓		
		8.4	Threshold Water Levels at Bjizam AWLS	✓		

2) Training Based on the Draft Manual

(1) Training for Central DHMS Staff

Training based on the O/M Manual draft for the hydrology division staff was organized on 29th June 2015. 10 counterparts took part in the training.

Topics of the training are described as below.

- Difference between GLOF and rainstorm flood
- Meaning of "Early" in the EWS
- Which is worse, "Air shot" or "Miss"?
- Necessity of threshold review by actual data
- Common and different points between the Existing and the New EWS
- Importance of keeping records such as log book

(2) Hands-on Trainings

The EWS installation works by JICA Contractor was delayed Therefore, hands- on trainings using installed EWS for NWFWC and two Control room staff were postponed in the 2nd Phase (September 2015 -).

3.4 Achievements of Output 3 Activities

All the Project activities on Output 3 "Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins" in the 1st Phase (September 2013 - July 2015) are described in this section.

The following activities implemented in the 2nd Phase (September 2015 – September 2016) are excluded.

- Develop SOP for GLOF/rainstorm flood in pilot basins (Activity 3-4)

3.4.1 Review Flood Emergency Response on Warning and Evacuation in the Pilot Basins (Activity 3-1)

1) Kick-off Workshop at the Central Level

The Community-based Disaster Risk Management (hereinafter referred to as "CBDRM") kick-off meeting was held on September 25th, 2014 at DDM with the participation of the Director of DDM, 7 staff of DDM, DHMS, JICA Experts and to introduce the objectives of the activities and planned activities as well as to clarify the role of DDM in the activities. The DDM has confirmed their involvement on the proposed activities at the District and Local levels. At the same time, the DDM has also discussed their efforts on capability building on CBDRM/disaster risk reduction planning. The DDM has conducted a sensitization session for communities along the Chamkharchhu. Safe areas were identified for each community in the event of GLOF occurring. Also, DDM has been conducting CBDRM training to develop CBDRM trainers. 36 officials from Bumthang were trained. Additionally, DDM has developed planning templates for Gewog (county) and Chiwog (sub-county) levels. The DDM also introduced their current manual on comprehensive CBDRM, and it was promised that The JICA Expert on CBDRM collaborating with the DDM was to review the draft manual towards finalization. The manual was reviewed in July 2015 as planned.

2) Kick-off Workshop at the District Level

Two workshops were conducted at the district level: At Trongsa District on September 29th, 2014 and at Bumthang District on October 1st, 2014. In the meetings the JICA Expert Team and C/Ps from DHMS and DDM introduced the Project and presented the proposed activities in the target communities, as well as the proposed approach to work with vulnerable communities. In Trongsa district, 15 participants from different government sectors, led by the Governor of Trongsa, engaged in the discussion after

the presentation. The Police were interested to know their role in the event of a flood. In Bumthang District, 17 participants representing the different government sector provided input on the direction the CBDRM activities may proceed. Participants mentioned that awareness-raising about the flood and the early warning system to be set-up to warn the public should also target travellers who frequently visit Bumthang Town. In both Districts, the different sector representatives expressed their support for the Project.

3) Kick-off Workshop at the Local Level

Three residential communities and one school community were initially proposed for evacuation planning using CBDRM. These were: Bjizam in Trongsa District, Wangdicholing, Chamkhar Town and Gangrithang Primary School in Bumthang District. Workshops were conducted in those communities and one school from September 30th to October 9th, 2014 to introduce the objectives of the Project, to review any existing flood warning or flood response practices, and to determine the level of interest and, therefore, the level of expected participation in each proposed community. All the communities showed high interest, and participants gave comments such as that all residents in vulnerable area (beside the river) should be invited to the planning workshop because the installation of siren would help the communities. Table 3.25 shows the number of participants in the kick-off workshops.

Table 3.25 Number of Participants for Kick-off Meeting

Workshop Location	Date (YYYY/MM /DD)	Number of Participants					Total
		Central		District	Gewog/ Tromde	Comm unity	
		DHMS	DDM				
Central/DDM	2014/9/25	2	8				10
Trongsa District	2014/09/30	1	1	14	1		17
Bumthang District	2014/10/01	1	1	16	1		19
Bjizam	2014/09/30	1	1	1	2	10	15
Wangdicholing	2014/10/07		1		1	11	13
Chamkhar Town	2014/10/07		1	1	1	21	24
Gangrithang Primary School	2014/10/09		1			1	2

Meetings were also held in Chokhortoe Primary School, the surrounding area of the school, Kurjey and Gyelkhar/Gongkhar, where the sirens have been installed to introduce the Project as well as to discuss the contents of activities.

3.4.2 Target Communities and Flood Warning Criteria in the Pilot Basins (Activity 3-2)

1) Preliminary Study

The preliminary study for selecting four target communities (and schools) for CBDRM from nine proposed warning siren installation sites is shown in Table 3.26.

Table 3.26 Preliminary Information for Selecting Target Communities for CBDRM

Mangdechhu Basin

No.	Name of Candidate Community (Warning Siren Tower Installation Sites)	General of the Community	Selection Priority	Output 3 Activity
1	Bjizam Village	The only small community with a few vulnerable households along the river in the Project Area (There is no other choice.)	Middle	CBDRM
2	Dam Site	Under construction and no permanent dam community (colony) so far <Out of objective of CBDRM, Objective of SOP>	-	-
3	Power Plant			

Chamkharchhu Basin

No.	Name of Candidate Community (Warning Siren Tower Installation Sites)	General of the Community	Selection Priority	Output 3 Activity
1	Choekhor Toe Primary School	-Located on the flood plain -83 pupils and 9 teachers -Quake mock drill every month -School has school disaster management plan	Middle	Explanatory meeting on the installed siren
2	Kurjey Village	-More than a dozen scattered vulnerable households -Specific vulnerable households are not yet identified.	Middle	Explanatory meeting on the installed siren
3	Wangdicholing Village	-More than a dozen vulnerable households -Under the danger of riverbank erosion as well as flooding	High	CBDRM
4	Bumthang Downtown	-Dense urban area (a hundred and several tens of households) -Several dozen vulnerable households	High	CBDRM
5	Gangrithang Primary School	-Located on the flood plain -Most dense population (377 pupils and 15 teachers) during daytime -Quake mock drill every month -School has school disaster management plan	High	CBDRM
6	Gyelkhar Village	-A few vulnerable households -Population might be increased in future	Low	Explanatory meeting on the installed siren

2) Mangdechhu Basin

In Mangdechhu Basin, Bjizam was selected after careful study in collaboration with the DDM and DHMS. The EWS siren under the Project was installed in June 2015 in the community. Flood warning and evacuation plan would be needed for Bjizam and, therefore, more workshops to develop the evacuation plan as well as practice the plan through evacuation drill have been recommended.

3) Chamkharchhu Basin

Two major factors were used to identify the target communities along the Chamkharchhu. These are the location of the flood warning siren and the exposure (vulnerability) of the communities to Flood (Population density, risk level and community cohesion). Through careful discussion with the DDM and DHMS, 4 big communities and 2 schools located along the Chamkharchhu basin were selected as shown below. The EWS sirens were installed in those communities and schools by June 2015.

A. Selected Community
   1. Kurjey (3 groups of Dawathang, Pangrey, Dorjibee)
   2. Wangdicholing
   3. Chamkhar Town
   4. Gyelkhar/Gongkhar

B. School
   1. Chokhortoe Primary School (there are some residential communities around the school which also could hear the siren. Therefore, it was decided to conduct an awareness-raising workshop for the surrounding communities)
   2. Gangrithang Primary School

Table 3.27 describes the target communities and schools.

Table 3.27 Summary Description of Target Communities

Basin	Community /School	Description
Mangdechhu Basin	Bjizam	A small established community which is the home for a primary school, the office of the Gewog, residents and businesses to cater to the needs of the residents as well as government offices such as the Department of Agriculture Common Facility for Medicinal and Aromatic Plants, Bjizam Weather Station and Department of Forestry. There are 50 households with 16 houses (and other structures) located on the river bank. About 50 people are at risk from flood and GLOF. The community experienced several floods in the past, and the awareness on flood is high.
Chamkharchhu Basin	Chokhortoe Primary School (including the surrounding residences)	The school is composed of 95 pupils, 7 teaching staff and 1 care taker. They have 2one-story classrooms and other buildings within the school compound. According to the hazard map, the whole compound is in the projected flood area. The ground of the school was inundated when Cyclone Aila hit in 2009. There are 6 communities existing around the school. Although the houses in those communities are outside of the projected flood area, 108 households are just outside of the projected flood area.
	Kurjey (Dawathang, Pangrey, Dorjibee group)	There are 64 houses for the 3 communities. All houses are located on the hillside away from the river. However, there is a suspension bridge that connects Dawathang to Pangrey and Dorjibee, and it is at-risk to flooding.
	Wangdicholing	74 persons in 12 houses are located in the flood prone area. The community experiences flood several times in the past and the river bank was eroded due to flood. The risk in this community is high. The community has high social interaction and bond.
	Chamkhar Town	There are 153 business establishments and residences in the town. Most of the shop owners live in the premises. Half of the town is in the projected flood area. The community also experienced inundation in Cyclone Aila. The risk level is high in the community. The residents display camaraderie and high social interaction showing strong bond as a community.

Basin	Community /School	Description
	Gangrithang Primary School	The school has 280 pupils, 20 teaching staff and 1 caretaker. There are one-story and two-story classrooms, a two-story building for teachers, and one-story building as the principal's quarters. All the buildings are in the projected flood area, and the risk in the school is high. The ground was inundated when Cyclone Aila hit.
	Gyelkhar/ Gongkhar	Half of the community is in the projected flood area, but only farm lands and occasional cow sheds are located in the area. While there are a few houses located close to the flood prone areas, they are constructed on a cliff well above the projected flood level. The community was selected since there are farm lands and cow sheds at risk to flood and the residents can hear the siren.

3.4.3 Plan and Conduct Evacuation Drill in the Pilot Basins (Activity 3-3)

Referring to the results of 3.4.2, Flood warning and Evacuation Plans were developed using the CBDRM approach at Bjizam in Trongsa, Wangdicholing, and Chamkhar Town in Bumthang. The two schools along Chamkharchhu have had experiences in developing a disaster management plan. While they have organized the disaster management team and some practices to evacuate during earthquake and flood, there is still a need to develop a flood evacuation plan in the light of the flood hazard map prepared by DHMS and the JICA Expert Team. Communities in the low-risk areas along the Chamkharchhu were guided to develop awareness-raising plan about the Flood EWS installed by the project. Table 3.28 describes the type of activities taken in the target communities and schools.

Table 3.28 Target Communities and Activities

River Basin	Community	Risk Level	Type of Activities based on EWS Warning Sirens Installed
Mangdechhu	Bjizam	High	Flood warning evacuation planning + Evacuation drill
Chamkharchhu	Chokhortoe Primary School (including surrounding communities)	High (Low)	Revision of existing school disaster management plan + Evacuation drill (Surrounding communities: Awareness-raising planning)
	Kurjey (Dawathang, Pangrey, Dorjibee group)	Low	Awareness-raising planning + Demonstration of evacuation drill
	Wangdicholing	High	Flood warning evacuation planning + Evacuation drill
	Chamkhar Town	High	Flood warning evacuation planning + Evacuation drill
	Gangrithang Primary School	High	Revision of existing school disaster management plan + Evacuation drill
	Gyelkhar/Gongkhar	Low	Awareness-raising planning + Demonstration of evacuation drill

1) Flood Warning Evacuation Planning Workshop

The flood warning evacuation planning workshops were conducted with the representatives of the communities in the following communities: Bjizam (June 10th and 11th, 2015), Wangdicholing (March 18th-20th, 2015) and Chamkhar Town (June 16th and 21st, 2015). All of the participants showed high interest on the workshops and they intensively participated in the workshops. The C/Ps from DDM, DHMS, District (District Disaster Focal Person), and Gewog (Gewog Administrative

Officer) also took the roles as facilitators with the JICA Expert Team. The following activities were taken in the workshops:

- Validated and updated of the hazard map
- Identified households and structures which are at-risk
- Selected safe evacuation place and evacuation route
- Prepared evacuation route map
- Formulated evacuation procedure
- Enumerated roles and responsibilities of evacuation management team
- Formulated action plan

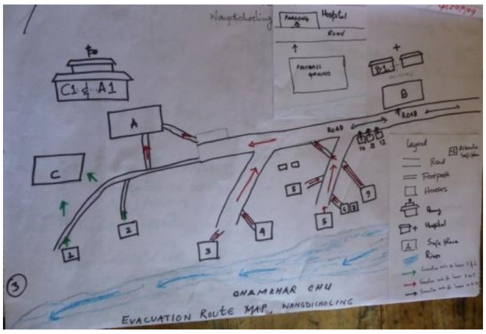
In those activities, the participants took the initiative with guidance from JICA experts and C/Ps.

Regarding the evacuation management team, it was decided that 10 members were to be selected from the hill side of the communities in Bjizam and Wangdicholing. In Chamkhar Town, the participants chose to select cluster leaders, instead of forming the evacuation management team. The leaders will take the lead on warning, evacuation and evacuation site management.

In action plans, it was promised that the participants would inform the contents and outputs of the workshops to their Gewog and other residents and the organization of evacuation management teams. It was confirmed that the action plan was completed accordingly in Wangdicholing during the follow-up meeting which was conducted on June 20th, 2015. The members of the evacuation management team also participated in the meeting, and their specific assignment and roles and responsibilities were reviewed.

In the 2nd phase, training for the evacuation management teams and cluster leaders are given and evacuation drills are conducted later.

Selection of households who are at risk



Evacuation route map which was drawn by participants

In those 3 communities, discussions on evacuation equipment were also conducted with the participants. The result of the discussions is shown in Table 3.29. The equipment procured in the 2nd phase of this project is used for the evacuation drills.

Table 3.29 Evacuation Equipment List

Equipment	Community		
	Bjizam	Wangdicholing	Chamkhar Town
Walkie-Talkie	10	10	10
Megaphone	3	3	10
Head lamp	10	10	10
Torch	10	10	10
Reflectorized vest	10	10	10
Folding Stretcher	3	5	-
First aid kit	3	3	-
Evacuation bag	-	12	-
Life jacket	6	-	-
Rain coat	7	-	-
Tent	9	-	-

2) Revision of Existing School Plan Workshop

The workshop was conducted on June 20th, 2015 at Gangrithang Primary School. In the workshop, an evacuation route map and evacuation procedures were prepared by the teachers. They also planned to disseminate the information about the evacuation plan to the parents and students.

In Chokhortoe Primary School, a meeting was held with the Principal and teachers to confirm the current disaster management activities taken in the school. The JICA Expert Team reviewed the current school disaster management plan.

3) Awareness-raising Planning Workshop

The workshops were held in Kurjey (Dawathang, Pangrey and Dorjibee group) on March 18th, 2015, in surrounding communities of Chokhortoe Primary School on March 22nd, 2015 and in Gyelkar/Gongkhar on June 18th, 2015. Similar to the other workshops, the participants intensively participated during the workshops to validate and update the hazard maps and to decide awareness-raising method in the communities. In the workshops, most of the activities were facilitated by the C/Ps. Follow-up meetings were held on June 18th, 2015 in the surrounding communities of Chokhortoe Primary School and Kurjye, and it was confirmed that they implemented the awareness-raising to the rest of the communities according to their action plan. Table 3.30 shows the number of participants in the CBDRM workshops.

Table 3.30 Number of Participants in CBDRM Workshops

Community	Date (YYYY/MM/DD)	Workshop Participants						Affected Population	
		Total	Central		District	Gewog/ Tromde	Community	Directly Affected	Indirectly Affected
			DHMS	DDM					
Flood warning evacuation planning workshop									
Wangdicholing	2015/03/18-20	12	1	1	1		9	74	300
Bjizam	2015/06/10-11	25	1		1	1	22	51	150
Chamkhar Town	2015/06/16,21	18	1		1		16	580	1,000
Integration of existing flood evacuation plan workshop									
Gangrithang Primary School	2015/06/20	20			1		19	300	600
Awareness-raising planning workshop									
Kurjey	2015/03/18	10	1	1	1	1	6	440	500
Chockhortoe Primary School (Activity of the surrounding communities)	2015/03/22	9	1		1	1	6	600	200
Gyelkar/ Gongkar	2015/06/18	17			1		16	100	200
Total		111	5	2	7	3	94	2,145	2,950

Chapter 4 The 2nd Phase Achievements (Sep. 2015 –Sep. 2016)

This chapter compiles all the achievements of the Project activities in the 2nd Phase (September 2015 – September 2016).

4.1 Achievements Related to Entire Project

All the Project achievements related to the entire project in the 2nd Phase (September 2015 - September 2016) are described in this section.

4.1.1 Seminars

1) Science Workshop at CST

On March 26, 2016, DHMS and the JICA Project Team held a Science Workshop at the College of Science and Technology (CST), Phuntsholing to disseminate the Project information to CST students and lecturers. The presentation topics were 1) the outline and progress of the Project and 2) flood hazard map.

2) 2nd Annual Seminar

The 2nd Annual Seminar was held on June 14, 2016 aiming at sharing the Project achievements with many stakeholders. Reflecting the high ownership of the Bhutanese side, most of the presentations were done by the C/P staff including the presentation by the DHMS and DDM director. Around 70 participants, not only counterpart agencies, relevant agencies, district focal persons, donors, media, NGOs but also VIPs such as the Minister of Economic Affairs and several National Assembly members showed a high interest in the Project. The program and the participants list are shown in Appendix 8.

4.1.2 Counterpart Trainings in Japan

(1) General

The Counterpart Trainings in Japan implemented four times during the 2nd Phase (September 2015 - September 2016) are shown in Table 4.1.

Table 4.1 Record of C/P Training in Japan

Type of training	Name of training	Period		Trainee	
		Duration (day)	Date	Number	Organization
Project custom-made	Administration on river management, EWS, weather observation and local government	12	Jan. 17 - 28, 2016	6	DHMS: 2 DoES NLCS DHS Trongsa District

Type of training	Name of training	Period		Trainee	
		Duration (day)	Date	Number	Organization
JICA ready-made	Comprehensive disaster risk management administration	48	Jan. 11 - Feb. 26 , 2016	2	DDM DoSE
	Strategy for resilient societies to natural disasters	48	Jan. 11 - Feb. 26, 2016	2	DDM DHS
	Capacity development for flood risk management with IFAS	28	July 3 - 30, 2016	2	DHMS Bumthang District

As for the Project custom-made course in January 2016, the trainees learned various disaster management in Japan from national, province, municipality, university and civil society. The trainees were interested not only in flood management but also in overall natural disaster management especially after the big earthquake that happened in Nepal on April 25, 2015.

(2) Debriefing Session on C/P Trainings in Japan

The 2nd Debriefing Session on the C/P trainings in Japan was held on July 27, 2016 at DHMS. The trainees who participated in the courses from May 2015 to February 2016 made presentations to widely share the knowledge and experiences with 16 staff of relevant counterpart agencies. The program is as shown in Appendix 9.

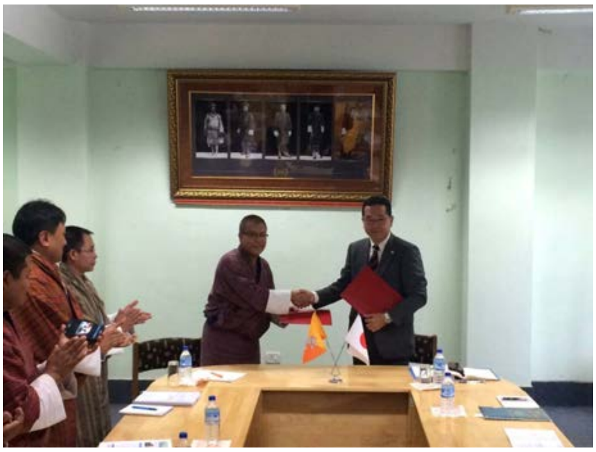
It is confirmed, through their presentations, that all the trainees learned a lot of useful things on disaster management and were very active and positive to share the knowledge and experience with other people.

4.1.3 Project Final Evaluation and the 3rd JCC Meeting

JICA Headquarters dispatched the Final Evaluation Mission from February 25 to March 15, 2016 to review the Project activity and achievements. The JICA Expert Team cooperated with the interview survey to C/P and relevant focal persons and field survey conducted by the Mission.

The 3rd Project Joint Coordinating Committee (JCC) meeting was held at DHMS on March 15, 2016. The meeting was attended by officials from central government agencies in Thimphu and disaster focal persons from two districts. The Draft Final Evaluation Report prepared jointly by Bhutanese and Japanese sides was discussed and agreed, and the Minutes of the Meetings was signed and exchanged. Among the five review criteria, the relevance, effectiveness, impacts and sustainability of the Project are considered to be high and the efficiency is considered to be relatively high.

4.1.4 Handover of Equipment Provided



The equipment provided and installed by the Project shown in Table 4.2 were officially handed over to DHMS on August 26, 2016. The important points stipulated in the Certificate of Handover signed on August 26, 2016 (refer to Appendix 12) are as follows:

Undertakings of DHMS: The equipment (GTS/MSS, EWS and HimawariCast receiving system) shall be operated and maintained properly and sustainably under the responsibility of the DHMS by securing sufficient budget as proposed in the Section 4.3.2 of this report.

Warranty against Defects by Japanese Side: The Japanese Contractor is required to warrant the quality of above-mentioned equipment during one (1) year from the date of the completion in March 2016.

Table 4.2 Equipment Provided

No.	Name of Equipment	Amount
1	Equipment for the GTS/MSS (including the operating system and manual)	1
2	Equipment for the GLOF/Rainstorm EWS in Mangdechhu and Chamkharchhu River Basins (including AWLS, AWS, control room, warning siren and communication system and the operating system and manual)	1
3	Equipment for the HimawariCast Receiving System (including the operating system and manual)	1
4	Backup Generator for the GTS/MSS and the EWS	3
5	Equipment for the flood evacuation drills for the target communities in Mangdechhu and Chamkharchhu River Basins	1
6	Computer	1
7	Multifunction Photocopier	1
8	Plotter	1
9	Projector	1
10	GPS	2
11	Range finder	2

4.1.5 Project Completion Report

This Project Completion Report (PC/R) compiles all the Project achievements throughout the Project period (September 2013 – September 2016). The PC/R meeting was held on August 26, 2016 with DHMS and other sub counterpart agencies to discuss the contents of the PC/R. The Minutes of the Meeting of the PC/R was signed on August 29, 2016 as shown in Appendix 13.

4.1.6 Technical Cooperation Outputs

The following Technical Cooperation Outputs prepared jointly by the C/P and the JICA Expert Team were submitted to Bhutanese side with the PC/R:

1) GTS/MSS Operation and Maintenance Manual (Activity 1-2)

2) Flood Hazard Map Preparation Manual (Activity 1-5)
3) Training Material for GPV Data Utilization (Activity 1-8)
4) Working Level Manual on Weather and Flood Forecasting (Activity 1-8)
5) SOP on Emergency Information Sharing in Central Agencies (Activity 1-9)
6) EWS Operation and Maintenance Manual (Activity 2-5)
7) SOP on Flood Early Warning and Emergency Response in Pilot Basins (Activity 3-4)

4.2 Achievements on Output 1 Activities

All the Project achievements on Output 1 “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced” in the 2nd Phase (September 2015 - September 2016) are described in this section.

4.2.1 Installation and Operation of Equipment for Integrated System (Activity 1-2)

1) Assistance for the Final Inspection of the GTS/MSS Equipment and Facilities

The GTS/MSS Equipment and Facilities were installed by JICA contractor. On 5/10~13/10 2015 the expert, who was tasked as the GTS/MSS Inspector by JICA, conducted the final inspection of the GTS/MSS system. The inspection also included on the job training.

After the inspection, based on the access to the actual devices, the operation training and implementation of the Operation and Maintenance Manual for GTS/MSS were started.

2) Preparation of Manual for GTS/MSS Operation and Maintenance

From Oct. 2015, the draft Operation and Maintenance Manual for GTS/MSS was revised according to the training results and discussion with C/Ps. The Operation and Maintenance Manual for GTS/MSS was finalized on March 2016. The contents of the Operation and Maintenance Manual for GTS/MSS is shown in Table 4.3.

Table 4.3 Contents of Operation and Maintenance Manual

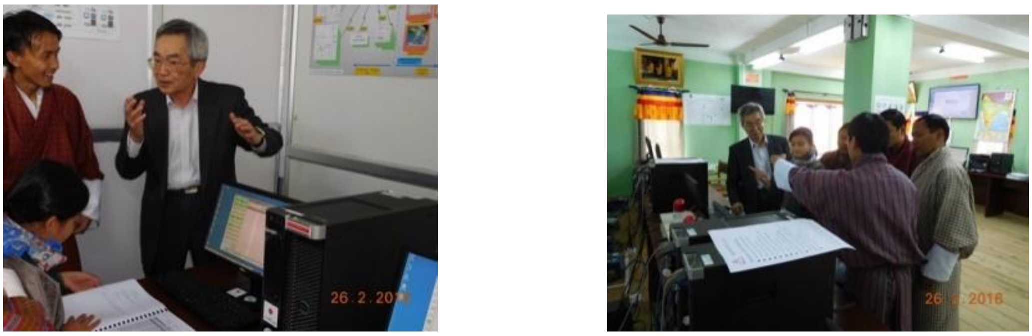
Operation and Maintenance Manual for GTS/MSS		
1 Introduction	1.1	Objective of the Manual
	1.2	Coverage of the Manual
2 The Role of Meteorological Organizations	2.1	The Role of DHMS
	2.2	Responsibility of WMO
	2.3	The Role of WMO
3 The Project Related Telecommunication System of DHMS	3.1	Relation to GTS in WMO
	3.2	Outline of Telecommunication System of DHMS
	3.3	The GTS/MSS System in NWFWC
4 Operation of the GTS/MSS	4.1	Startup of the GTS/MSS
	4.2	Monitoring the GTS/MSS System
	4.3	Table Maintenance
	4.4	The Method to Configure the Routing Table
	4.5	Trouble Shooting

	4.6	Contact Points of Related Organizations
5 Maintenance of the GTS/MSS	5.1	Preparation of Log Book
	5.2	Periodic Check
6 Duty and Responsibility for Operation and Maintenance	6.1	Meteorology Division
	6.2	Duties and Assignment
	6.3	Shift Duty of Operator
	6.4	Shift Operation
Appendix I	Technical Regulations	
Appendix II	Responsibilities of Centers on MTN (WMO Doc. No.386 Attachment I-3)	
Appendix III	Explanation of Data Designators	
Appendix IV	Explanation of GTS/MSS Manager Window	

3) Training for Operation and Maintenance of GTS/MSS

Based on the Operation and Maintenance Manual for GTS/MSS and using actual GTS/MSS devises, the following trainings for C/P were conducted.

- To realize the relation sharing responsibility between DHMS and WMO/IMD/TMD.
- To understand the configuration and the function of the installed GTS/MSS.
- To see the aspect of input data status from IMD/TMD
- To monitor the data from the Mangdechhu and the Chamkharchhu observation sites.
- To monitor the transmitted observation data from DHMS to IMD.
- To monitor the SATAID data from JMA.
- To make coordination about the category of exchanging data between IMD/TMD.
- To monitor the received warning messages.
- To get better understandings of how to deal with troubles.
- To record the Log Book. Table 4.4 shows the sample of the Log Book



Pictures of Training for Operation and Maintenance

Pictures of Training for Operation and Maintenance

Table 4.4 Sample of the Log Book

The Log Book of the GTS/MSS

Routine Check

Year: 2016

Date/ Time: 18th March/ 10:00

Status of Communication Link and Electric Power Supply

Category		Status	Time(UTC)	Note
Internet for GTS	DEMS	100%	10:10	
	VTBB	60%	10:14	Tried second time, result =100%
Electric Power Supply	NWFWC	✓		

1.1 Communication Status GTS Server		
Circuit Monitor Window	Good	Not Good(Condition)
002 DEMS AN Rx	✓	
003 DEMS BI Tx	✓	
004 DEMS BI Rx	✓	
011 VTBB AN Tx	✓	
012 VTBB AN Rx	✓	
013 VTBB BI Tx	✓	
014 VTBB BI Rx	✓	

From 14 March to 23 March 2016, the training workshop about the basic operation of GTS/MSS for the forecasters, who were assigned to shift operation, was conducted.

On 24 March, the 24/7 operation procedures of GTS/MSS were explained to the Director General of DHMS. He agreed to conduct 24/7 shift operation of the GTS/MSS. Table 4.5 shows the Shift Duty for the operation.

Table 4.5 The Shift Duty

Shift Duty	Duty Hours	Personnel
Morning Shift	06:00am-02:00pm	A
Afternoon Shift	02:00pm-10:00pm	B
Midnight Shift	10:00pm-06:00am	C
Off Duty	-	D

The first midnight shift of C/P

TV interview about the new Forecasting System

4) Installation of HimawariCast Receiving System

The new Japanese Meteorological Satellite Himawari 8 was launched in October 2014, and has been routinely operated from August 2015. JMA is operating the Satellite Imagery Providing System, which is called the HimawariCast. In March 2016, the HimawariCast Receiving System was installed at NWFWC. The HimawariCast Receiving System passed the inspection on 8 March. The contractor conducted the OJT during the installation with the C/P as participants.

The HimawariCast Receiving System made it possible,

- To make use of 16 channel sensor’s data
- To make use of the Global Image Data, every 10 minutes
- To make use of the SATAID, which is provided by JMA and is applied for weather analysis
- To make use of foreign countries Synoptic Data, Upper Air Data, etc.

Using these data, the Meteorological Expert carried out the Training for forecasters during the period of March, May and June 2016.

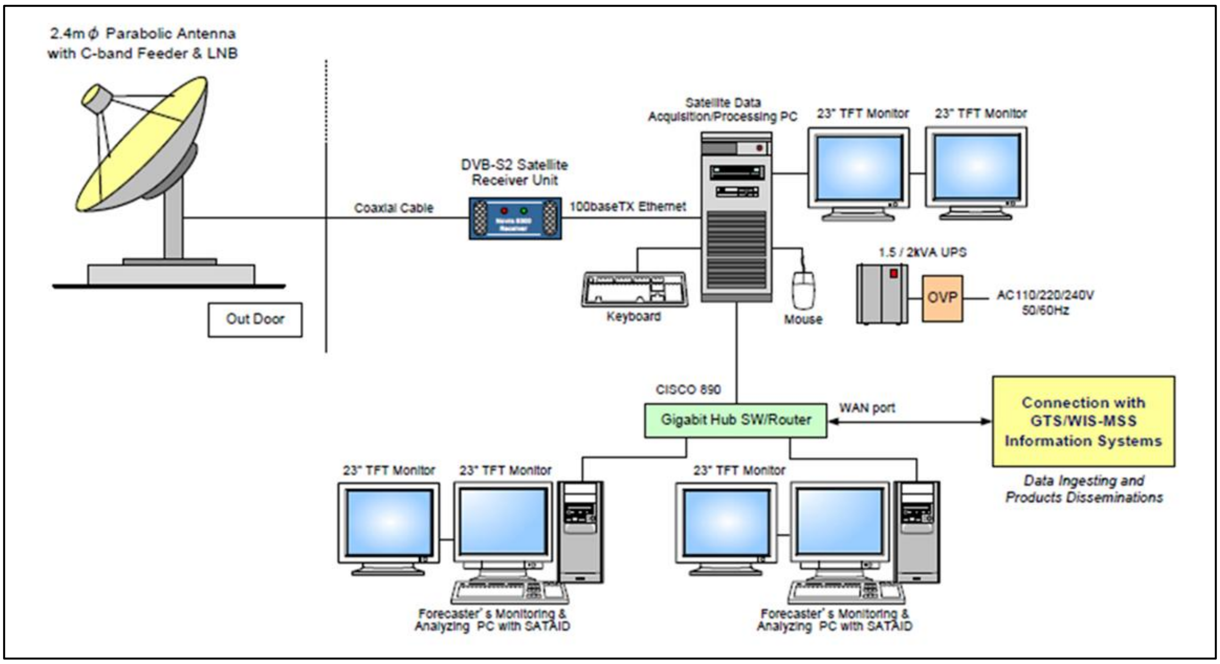


Figure 4.1 The Configuration of the HimawariCast Receiving System

4.2.2 Enhancement of Coordination between Risk Assessment Sector and Development Sector (Activity 1-4)

The 5th workshop of Flood Hazard Map Working Group (FHM W/G) was held on March 21, 2016 with 13 members including the new participants from the Department of Roads. The topic was the flood hazard map usage and the role of each agency in the preparation of the hazard map.

In addition to the above, the workshops of MDRR Working Group (MDRR W/G) on the Activity 1-7 (refer to Section 4.2.4) and Activity 1-9 (refer to Section 4.2.6) have also enhanced the future permanent coordination between risk assessment and development sectors.

4.2.3 Preparation and Improvement of Hazard Map through Training (Activity 1-5)

1) Finalization of Flood Hazard Maps

In order to add the evacuation site locations on the flood hazard maps, the JICA experts had visited the communities where the evacuation drills were conducted. The field survey schedule was from 8th to 13th November 2015.

As the result of the field survey for the planned evacuation sites, it became clear that sediment disaster (rock fall / slope failure) dangerous points are located on some of evacuation routes. Therefore, the JICA experts recommended for the community peoples to change the evacuation sites. Hence, some of the sites were shifted. Additionally, the sediment disaster dangerous points were added on the flood hazard maps and noted for vulnerable people to pay attention at the time of evacuation (Figure 4.2)

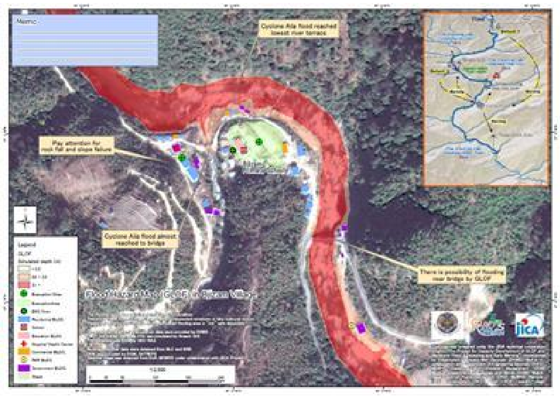
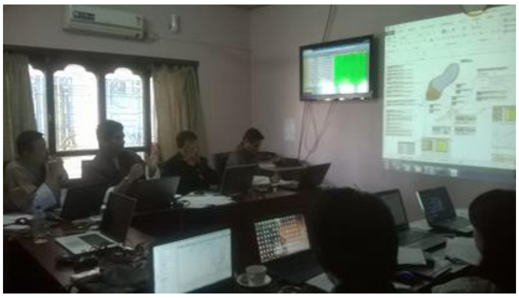


Figure 4.2 Example of Finalized Flood Hazard Map
(Bjizam)

The finalized flood hazard maps were distributed to the communities and Dzongkhag Disaster Management Officer (DDMO) in August 2016.

2) Trainings on Runoff/Flood Analysis

A training on GIS and runoff analysis was conducted for one FEMD C/P on 19th November 2015. For DHMS C/Ps, a training on runoff and lake breach analysis was held from 23rd to 27th November 2015 at Punatsangchhu EWS Control Room, Wangdue with 8 participants. Furthermore, OJTs to transfer techniques on GLOF simulation and field work were conducted in April and August 2016. As an outcome of transferring techniques, one of the DHMS C/P joined in the training as a lecturer.



Picture of Runoff/Flood Analysis

Materials prepared for the trainings were revised and compiled as part of the Flood Hazard Map Preparation Manual (Technical Cooperation Output 2).

3) Finalization of Flood Hazard Map Preparation Manual

A draft of Flood Hazard Map Preparation Manual was shared at the 5th FHM W/G workshop held on 21st March 2016. After that, the Manual was revised and finalized in August 2016 and distributed to C/Ps. The Manual has three major contents: 1. Outline of flood risks in Bhutan and expected impacts of flood hazard maps; 2. Flow of flood hazard map preparation and roles of relevant agencies (guidelines); and 3. Practical procedures of runoff/flood analysis (technical part).

4) Trainings and Flood Hazard Map Preparation in Other Basins

A training on runoff/flood analysis was held for 6 FEMD C/Ps from 9th to 11th March 2016. Samdrupjongkhar City, where flood occurred in August 2015, was selected as a target of analysis during the training. After the training, FEMD finalized the flood hazard map in the Samdrupjongkhar City based on the training results (Figure 4.3). FEMD had completed river cross-section survey by themselves before the training and updated the base data for flood analysis. This suggests their technical capacities have been developed. Besides, features of buildings and infrastructures were provided by JICA Project on Establishment of National Geo-Spatial Data Infrastructure for Bhutan.

A training on lake breach and flood analysis was held from 29th March to 1st April 2016. Participants were from DHMS (6), DoES (2), DGM (1) and DoR (1). On the training, a draft flood hazard map for Wangchhu River, Thimphu city was prepared. After the training, DHMS C/P finalized the flood hazard map shown in Figure 4.3.

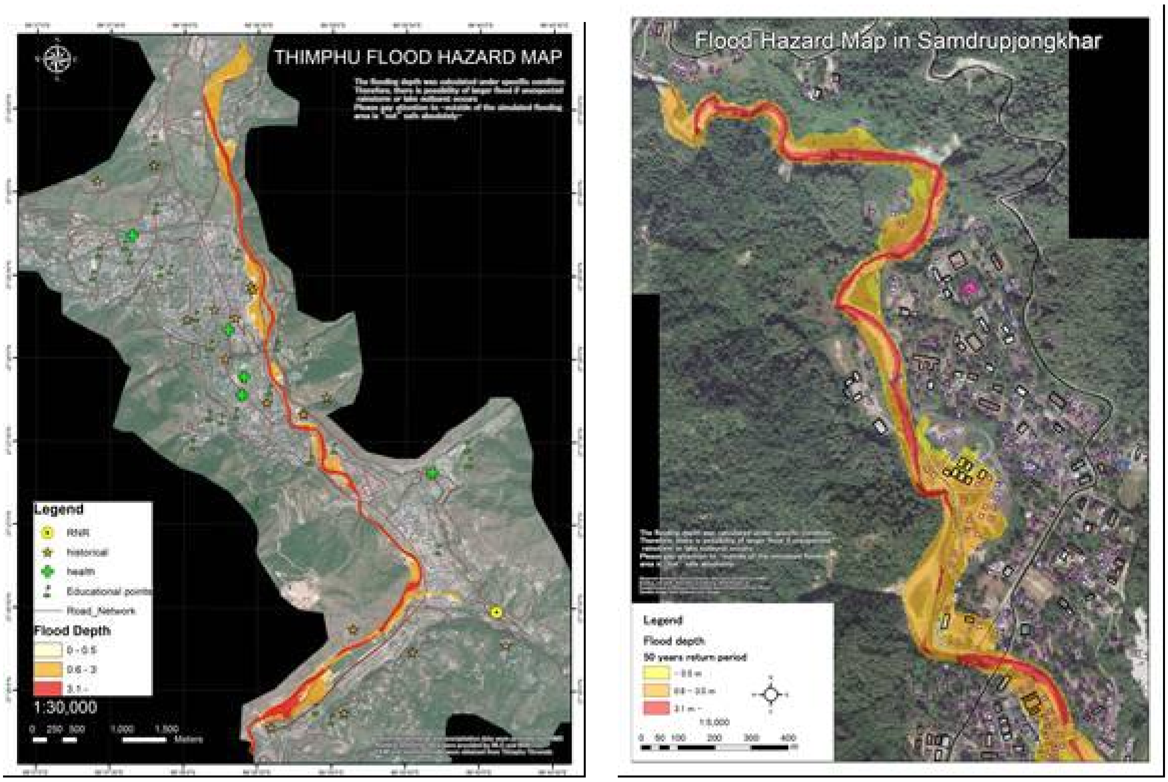


Figure 4.3 Flood Hazard Maps Prepared by C/Ps Based on Training Results

(Left: Thimphu City, Right: Samdrupjogkhar City)

4.2.4 Institution and Legal System for Mainstreaming Disaster Risk Reduction (Activity 1-7)

On October 26, 2015, it was discussed and agreed with DDM and DHMS that it would be essential to establish the Inter Ministerial Task Force (IMTF) stipulated in the Disaster Management Act 2013 rooted on the Project Working Group as appropriate institution as soon as possible. On October 27, it was agreed with DDM that DDM would proceed with the preparation to gain the approval of the establishment of the IMTF in NDMA to be held in 2016. DDM would prepare the draft TOR of the IMTF and JICA Expert Team would provide the substantive material to DDM.

On February 24, 2016, the 5th workshop of the MDRR W/G was held to discuss the idea of the draft IMTF TOR. A representative from the Department of School Education (DoSE) attended the Workshop as a new W/G member. It was concluded that DDM would prepare the draft IMTF TOR based on the discussion and the W/G members would continue the discussion based on the draft TOR in the next workshop.

On Aug 2, 2016, the 7th workshop of the MDRR W/G was held. DDM presented the draft IMTF TOR prepared. The main points of the draft TOR were 1) several Working Groups of the IMTF would be established based on disaster type as required, since the DM Act 2013 stipulates only one IMTF and 2) the Working Group will review and advice and not to implement practical work like hazard mapping. The W/G members discussed these based on the DDM presentation.

The Minutes of the Meetings are shown in Appendix 11.

4.2.5 Flood and Weather Forecast Utilizing the Numerical Weather Prediction (GPV) (Activity 1-8)

1) Preparation of Training Material and Manual, and Implementation of Training

The draft Training Material for GPV Data Utilization (Technical Cooperation Outputs) was prepared by the JICA Expert in November 2015. Afterwards, the training on the utilization of SATAID and GPV data based on the training material was held in March 2016.

The draft Working Level Manual on Weather and Flood Forecasting (Technical Cooperation Outputs) was prepared by the JICA Expert in November 2015. The training, based on the manual, was implemented for seven (7) counterparts in Meteorology Division (MD), DHMS on 13, 16 and 17 November 2015. Based on the results of the training, the Expert reviewed and modified the draft manual.

The SATAID application with its automatic data acquisition software on the computer used at weather forecasting operation in the MD, was installed by the Expert and displayed the SATAID animation of cloud imagery with GPV data on 25 November 2015. On 27 November 2015,

On 27 November 2015, the Expert inspected the Simtokha Class A (Agricultural) Station in order to gather information which might contribute to the preparation work of the Manual.

Inspection for Class A Station

Training on the SATAID with GPV data

The review of the contents and components of the draft Working Level Manual on Weather and Flood Forecasting was done in cooperation with seven (7) C/Ps on 4 December 2015.

On 8 December 2015, a C/P who had been trained in Japan made a presentation on the positive results of the JICA group training course on meteorological capacity building. On the same date, Deputy Director of MD, DHMS made a presentation on the results of the two-month comparison between forecasted values and observed values of weather outlook, maximum temperature and minimum temperature.

In November 2015, the relay of the JMA GPV data in binary form through the GTS/MSS was negotiated with the Regional Telecommunication Hub (RTH)s New Delhi and Bangkok, within the WMO Regional Association II(Asia). C/P had continued negotiations on their relay, under the advice of the Expert until, finally, data started to be received at the DHMS on 8 December 2015.

In March 2016, practical trainings on the effective utilization method of SATAID with GPV data based on the draft Working Level Manual on Weather and Flood Forecasting and the draft Training Material for GPV Data Utilization was conducted. The new HimawariCast System, installed in March, was used in the training. Afterwards, two C/Ps presented the results of the practical training on 28 March 2016.

In May 2016, a C/P prepared the comparison tables, by himself, between forecasted values and observed values of maximum/minimum temperature at all 20 Class A Stations in Bhutan for the entire 2015. Based on the results of the comparison, the C/P started the practical importation of the JMA NWP Global Spectral Model (GSM)'s GPV data into daily forecasting operation, in trial basis, for the purpose of improving their forecast starting 20 May 2016.

A practical training, including commentary, on the definite procedures for the data importation was conducted on 9 June 2016. The training was in advance of the introduction for their operational shift works. The training used the big display of the HimawariCast System and was based on the draft Training Material for GPV Data Utilization. All MD staffs attended the training.

Because such practical GPV data imports for their daily forecasting operation requires enormous trials and comparisons of the data, it will take several years for MD staffs to improve their forecasting skills up to a certain level of efficiency.

The trial imports of JMA GPV data

Practical training on the imports for all MD staffs by C/P

Because no legal infrastructures exist to support and regulate the current service of MD, DHMS, the Expert illustrated the necessity of such regulation which includes the concept of Intellectual Property Rights, an example of which is the use of satellite images taken by the HimawariCast System. It was recommended that the C/P engage in planning at DHMS to introduce such regulation following the JMA's Meteorological Service Act. The planning took place on 14 March and 19 May 2016.

With the establishment of the new GTS/MSS and HimawariCast System at the NWFWC in March 2016, the Expert recommended that the MD to increase the frequency of issuing forecast from one to three times a day, simultaneous to the commencement of three shifts (two staffs each) in 24hours starting 29 March 2016. The subject for increasing forecast frequency is under consultation with a broadcasting company in Thimphu.

As the operational start of Tsampa AWS station was officially reported to the WMO Secretariat on 24 March 2016, the MD began to transmit the Tsampa surface data manually two times a day through the GTS starting 29 March 2016.

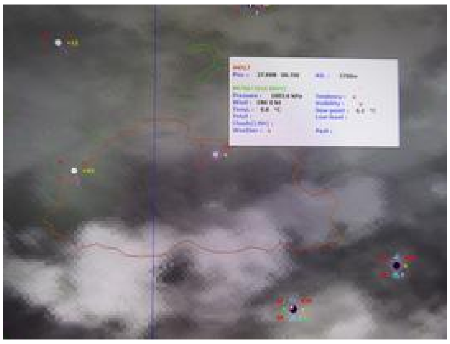
Since the JMA HQ had not received the Tsampa surface data by the middle of May 2016, the C/P coordinated with the RTHs New Delhi and Bangkok to switch the data to other GTS Centers. Finally, by 26 May 2016, the RTHs in New Delhi and Bangkok started to send the data to all the WMO Member Countries.

On 2 June 2016, a C/P made a presentation on how to use the SATAID with GPV data for operational weather forecasting at the Royal Thimphu College (RTC) where the C/P is enrolled. The Expert also made presentation on the outline and purpose of the JICA GLOF Project.

C/P's presentation at the RTC

Expert's presentation at the RTC

Since the registration of Tsampa surface data at JMA's SATAID Broadcasting System done officially on 9 June 2016, the data began to appear at the SATAID display in the HimawariCast System at the NWFWC, as the first SATAID weather station in the Kingdom of Bhutan.



Tsampa's surface data on the SATAID display

Practical Trainings by JMA's Experts

As the results of repeated preparation works and practical trainings on/by the Manual/Material on the Basic Weather Forecasting Techniques and Synoptic Weather Analysis using SATAID with GPV data, the theoretical skill of C/Ps in MD, DHMS, was improved greatly that they could import the JMA GPV data into their daily forecasting operation.

For the future challenges, it should be important to assess their trial results at first. If it is assessed that they could achieve higher level, further trainings on trial import of more fine mesh grid products, i.e. JMA NWP Regional Spectral Model(RSM)'s GPV data, should be conducted by a JICA Expert as part of the C/P's continuing training.

2) Support for the SATAID Practical Training by JMA Experts

In response to the establishment of new HimawariCast System at the NWFWC in March 2016, two Experts were dispatched from JMA through the courtesy of JICA.

Under the support of the GLOF project team, these Experts implemented the practical trainings especially on the case study for significant weather actually occurring in Bhutan. The Experts applied SATAID with GPV data received through HimawariCast System during the training for 14 staffs of MD, DHMS, from 7 to 9 (three days) June 2016.

4.2.6 SOP on Emergency Information Sharing at Central Level (Activity 1-9)

In May 2016, DHMS counterparts and the JICA Expert Team discussed the emergency information sharing at central level, that is, the information transmission and dissemination from NWFWC, DHMS to the related central agencies including DDM and media. The information includes the GLOF/ rainstorm flood information by Hydrology Division, DHMS and the weather information for disaster prevention by Meteorology Division, DHMS.

On June 7, 2016, the 6th workshop of the MDRR W/G was held. In order to prepare the SOP, the issuing, sharing, flow and type of the emergency disaster related information from NWFWC to central agencies in Thimphu including DDM were discussed.

On August 2, 2016, the 7th workshop of the MDRR W/G was held. The draft SOP prepared based on the last workshop was discussed. The overall emergency information flow is as shown in Figure 4.4. Through the experience of the big monsoon flood in July 2016, it is proposed to promote active utilization of SNS such as Facebook or Twitter with prompt transmission and wide range of dissemination in addition to the traditional way such as telephone, e-mail and SMS.

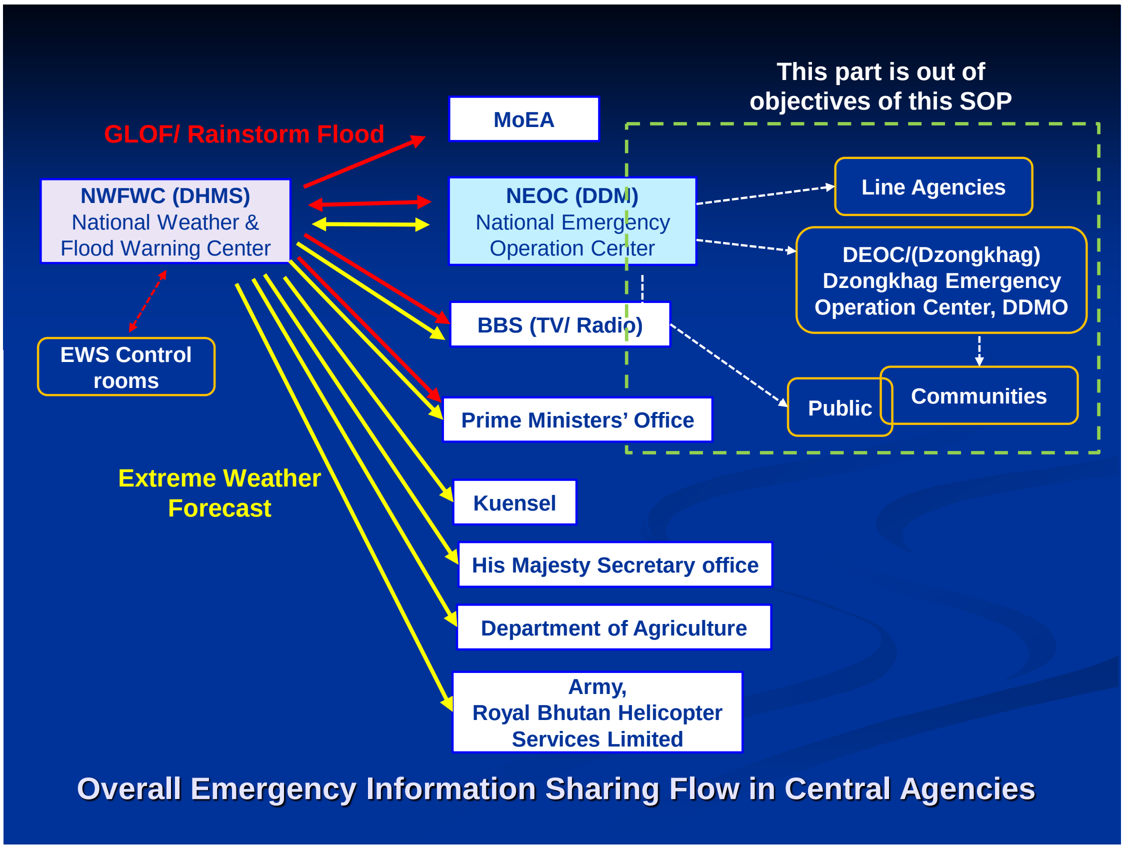


Figure 4.4 Emergency Information Sharing Flow in Central Agencies

The Minutes of the Meetings is shown in Appendix 11.

The "Standard Operation Procedure on Emergency Information Sharing in Central Agencies", Technical Cooperation Output, is attached to this report as separate volume.

4.3 Achievements on Output 2 Activities

All the Project achievements on Output 2 "Early Warning System (EWS) for GLOF/rainstorm are developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu" in the 2nd Phase (September 2015 - September 2016) are described in this section.

4.3.1 Installation of EWS Equipment in the Pilot Basins (Activity 2-4)

1) Supporting Installation of Equipment and Final Inspection

The JICA Expert Team assisted the interim inspection from October 5 to 13, 2015 for the EWS equipment installed along Mangdechhu and Chamkharchhu basins by the JICA Contractor (Helicom Corporation Inc.) from September to October 2015. It was confirmed that the EWS started to operate as a whole. Accordingly, the Team and the C/P started the preparation of the EWS Operation and Maintenance (O & M) Manual and the O & M trainings using the EWS in operation since October 14, 2015.

The JICA Expert Team and DHMS assisted the remaining installation work conducted by the JICA Contractor from February 24 to March 15, 2016. The Team and DHMS assisted the final inspection on March 16, 2016 and it was confirmed that all the EWS equipment installed passed the inspection.

What is notable is that DHMS dispatched many staff to the Pilot Project Areas for around 4 months (September to October 2015 and February to March 2016), at its own expense, to assist the EWS installation work by the JICA Contractor with the cooperation of the JICA Expert Team.

After that, the EWS has been in full working order. Therefore, the DHMS started 24/7 EWS operation by May 5, 2016.

The JICA Expert Team and DHMS assisted the field service maintenance work for the EWS conducted by the JICA Contractor from May 25 to June 3, 2016.

2) Installation of Backup Power Generator for EWS

Although the installed EWS are equipped by Uninterruptible Power supply Systems (UPS) for safety shutdown and restart of the system, it cannot secure the continuous operation during power failure. In order to secure backup power in emergency, three (3) diesel power generators with AMF panels were procured and installed into the NWFWC in Thimphu and the Control Centers in the basins. The operation and maintenance of the generators were instructed in the EWS O/M manual indicated in the Section 0.

3) Revision of Alert/Alarm Levels of EWS

The initial Alert/Alarm levels of EWS were set based on the past manual observation records of river water levels and flood marks (refer to Section 3.3.4). After the EWS operation started, water levels at all stations have been continuously recorded including the flood on 26th July 2016 which was caused by continuous rainfall in the monsoon period. Then, it was judged that enough water level records to revise the initial Alert/Alarm levels were obtained. Table 4.6 shows the revised Alert/Alarm levels at all AWLS. The Alert levels which had been initially set as safer value were increased based on the observed water level in the monsoon period 2016. In contrast, the Alarm levels were decreased or increased depending on the characteristics of each AWLS considering high water level marks of the flood on 26th July 2016. The Alert/Alarm levels should be revised continuously depending on the accumulation of observed water level data and change of river bed condition.

Table 4.6 Revised Alert/Alarm Levels at All AWLSs

River	Water Level Station	Alert Level		Alarm Level	
		Initial	Revised	Initial	Revised
Mangdechhu River	Jongthang	5.6m	**5.9m**	7.9m	**7.0m**
	Bjizam	3.8m	**4.2m**	5.0m	**5.5m**
Chamkharchhu River	Tsampa	4.9m	**5.0m**	6.7m	**6.5m**
	Kagthang	5.5m	5.5m	6.8m	**6.0m**
	Kurjey	3.0m	**3.3m**	4.1m	**5.0m**

Note: above Alert/Alarm levels should be revised depending on the accumulation of observed data and change of river bed condition.

4.3.2 Preparation of Manual for EWS Operation and Maintenance and Training (Activity 2-5)

1) Preparation of EWS Operation and Maintenance Manual

(1) Process of the Activity

Process of the activity following the first phase is shown in Table 4.7.

Table 4.7 Activity Process on Preparation of EWS O/M Manual

Date			Activity	Contents	Participant /Executant
Day	Month	Year			
5	Oct.	2015	Inspection	Watching for OJT by JICA Contractor	1~4
13					
14			Meeting	Work Policy, Scheule	2
15			Writing	O/M Manual Draft for Control Rooms	3
5	Nov.		Checking		
6			Meeting	Training Contents and Schedule for Operators in the CRs	5
7			Training	Basic Knowledge, Operation, Maintenance for Operators in the CRs	5
13					
16			Writing	O/M Manual Draft for FMCR	3
18			Checking		
19			Training	Basic Knowledge, Operation, Maintenance for Operators in the FMCR and Staff of HD	9
17	May	2016	Training	Work Policy, Scheule	2
18			Writing	Long-term Maintenance Plan, Renewal Cost Annual Quraterly Maintenance Plan	2
20			Checking		
23			Writing	O/M Manual for Control Rooms	2
27			Checking		
28			Training	Quraterly Maintenance, Information Searing Service for Operators in the CRs	2~5
3	Jun.				
6			Writing	O/M Manual for Control Rooms for Flood Monitering and Command Room	3
17			Checking		
18			Training	Restoration HF communication between CR and SSs in Chamkarchhu Basin	4
20					

* CR: Control Room
* FMCR: Flood Monitoring and Command Room

In October 2015 a part of the second phase, DHMS staff could touch and operate the EWS actually because the JICA Contractor almost finished installation and regulation works at the time. The final versions of the operation manuals for the system software were submitted by the Contractor. After that the activity team integrated them into the O/M Manual and completed the draft version in October and November. DHMS operators in both control rooms were trained using the draft O/M Manual as the EWS started provisional operation.

In February and March 2016 the JICA Contractor had solved the remaining problem encountered in October 2015 and passed the completion inspection. On another front, the development of the SOP for GLOF/rainstorm flood in pilot basins (Activity 3-4) proceeded. Contents of information sharing service under flood condition were finalized while installation works of engine generator to ensure continuous operation during power failure were implemented. In June 2016 the activity team used these developments and included into the O/M Manual, thus completing the final version.

(2) Title of the Manuals

The Manuals were prepared as three (3) separate volumes for both control rooms and for the flood monitoring/command room in NWFWC in DHMS. Titles of the manuals are as below.

- OPERATION AND MAINTENANCE MANUAL FOR THE GLOF AND RAINSTORM FLOOD EARLY WARNING SYSTEM (FEWS) THE MANGDECHHU BASIN FEWS
- OPERATION AND MAINTENANCE MANUAL FOR THE GLOF AND RAINSTORM FLOOD EARLY WARNING SYSTEM (FEWS) THE CHAMKHARCHHU BASIN FEWS
- OPERATION AND MAINTENANCE MANUAL FOR THE GLOF AND RAINSTORM FLOOD EARLY WARNING SYSTEMS (FEWS) IN MANGDECHHU AND CHAMKHARCHHU BASINS THE FLOOD MONITORING AND COMMAND ROOM IN NWFWC

(3) Contents of the O/M Manual

The Contents of OPERATION AND MAINTENANCE MANUAL FOR THE GLOF AND RAINSTORM FLOOD EARLY WARNING SYSTEM (FEWS) THE MANGDECHHU BASIN FEWS are shown in Table 4.8. The other two (2) volumes have the same contents except the sections where the information unique to the basins and systems is replaced.

Table 4.8 Contents of EWS O/M Manual

OPERATION AND MAINTENANCE MANUAL FOR THE GLOF AND RAINSTORM FLOOD EARLY WARNING SYSTEM (FEWS) THE MANGDECHHU BASIN FEWS JUNE 2016				
Chapter		Section		Remark
1	Introduction	1.1	What is this Book	Preparation in 1st Phase
		1.2	Scope of this Book	
2	Basic Knowledge	2.1	Flood	Preparation in 1st Phase
		2.2	Flood Countermeasure	
		2.3	Flood Early Warning System (FEWS)	
3	Characteristics of the Mangdechhu Basin	3.1	Outline	Preparation in 1st Phase
		3.2	Glacial Lakes	
		3.3	Probable Flood Discharge	
		3.4	Flood Arrival Time	
		3.5	Flood Prone Areas	
		3.6	Dam and Power Plant	
4	The System	4.1	Whole System	Preparation in 2nd Phase
		4.2	Flood Early Warning System (FEWS)	
		4.3	Main Communication System	
		4.4	Sub Communication System	
		4.5	Equipment of Each Station	
5	Operation of the System	5.1	Graphic-user-interface	Preparation in 2nd Phase
		5.2	The Operation Screen	
		5.3	The Monitoring Screen	
		5.4	The Controller for the AWLSs	
		5.5	The Controller for the SSs	
		5.6	Radio Communicaton with the FMCR and with the Dzong	
6	Warning Service	6.1	Warning Process	Preparation in 1st Phase Amendment in 2nd Phase
		6.2	In Case of GLOF	
		6.3	in Case of RSF	
		6.4	Information Sharing	
		6.5	Manual Siren Activation	
		6.6	False Alarm	
7	Maintenance Service	7.1	Type of Maintenance and Unit in charge	Preparation in 1st Phase Amendment in 2nd Phase
		7.2	Daily Check	
		7.3	Quarterly Maintenance	
		7.4	Repair Work	
		7.5	Spare Parts	
		7.6	Consumable Supplies	
		7.7	Tools and Equipment	
		7.8	Engine Generator	
8	Thereshold Water levels at the AWLSs	8.1	Principle	Preparation in 1st Phase
		8.2	Setup the Value	
		8.3	Threshold Water Levels at Jongthang AWLS	
		8.4	Threshold Water Levels at Bjizam AWLS	
9	The Operators	9.1	General	Preparation in 2nd Phase
		9.2	Shiftwork	
		9.3	Duties of the Operators	
Appendix		1	Data Transmission Scheme	Preparation in 2nd Phase
		2	Desiccant Replacement of the Bubble Gauge	
		3	Example of Yearly Maintenance Plan	
		4	Manual Siren Activation Test	

2) Training Based on the O/M Manual

(1) Training in 2015

The EWS installation works finished and provisional operation was started in October 2015. Trainings based on the draft O/M Manual for the operators were implemented so that they can operate daily. At the same time the operators were required to master the manual siren operation during the mock drill in March 2016.

Hands-on Training for Operators of the Control Rooms in Basins:

Hands-on trainings for operators of the control rooms in Chamkharchhu and Mangdechhu basins were implemented on 7th to 13th November based on the draft O/M Manual. Contents of the training were: introduction of the manual; operation of the EWS; log books entry; communication on the HF radio; and quarterly maintenance for automatic water level stations and siren stations.

Hands-on Training for Hydrology Division Staff:

Hands-on training for hydrology division staff in DHMS and operators of the flood monitoring/command room in NWFWC was implemented on 19th November based on the draft O/M Manual. Contents of the training were: introduction of the manual; operation of the EWS; log books entry; communication on the HF radio; and input river cross-sections.

(2) Training in 2016

The operators had seven (7) months of experience in EWS operation by May 2016 since provisional operation started in November 2015. They already got enough skills on daily operation and log books entry. Therefore, the training in 2016 focused on quarterly maintenance of the EWS and information sharing service under flood condition.

Hands-on Training of Quarterly Maintenance:

Desiccants in the bubbler gauges of AWLSs need to be changed quarterly. The quarterly maintenance services including desiccant change for 5 AWLSs in both basins were implemented 28th May to 2nd June as on-the-job training. All desiccants were changed.

Training of information sharing service under flood condition:

Workshop for the development of SOP in pilot basins was held at MHPA on 3rd June. The attendees discussed information sharing under flood condition. They visited the control room of the EWS in Mangdechhu basin after the workshop and the operators explained the equipment. They increased their knowledge on information sharing under flood condition. Contact lists under flood condition were being finalized. Contacts and calls on drill under flood condition will be implemented using finalized contact lists.

Recovery Work on HF Communication:

The HF communication of the EWS was down on 11th June in Chamkharchhu basin. Improper operation of the HF transceivers seemed to be the cause of the malfunction. Communication between the control room and the automatic water level stations recovered after a while but communication between the control room and the siren stations had been out of order. Two of hydrology division staff with the JICA expert succeeded recovery work on 19th June as part of on-the-job training.

3) Long-term Maintenance for the EWS

The key point for long-term sustainability of the EWS is an ensured renewal budget for electronic equipment which generally has short life time. The activity team estimated electronic equipment renewal cost for 30 years. The total cost was estimated as 93 million BTN. DHMS was aware of the importance of ensuring the budget in a planned and steady way.

Table 4.9 Estimated Renewal Budget for Electronic Equipment of EWS

Site Code	Item No.	Description	Q'ty	Unit	Unit Price	Price	Lifetime	Renewal Cost (BTN)					
								2020	2025	2030	2035	2040	2045
					BTN	BTN	Year	5	10	15	20	25	30
TMP-GTS	TMP-GTS-04	Server	1	set	158,220	158,220	10		158,220		158,220		158,220
	TMP-GTS-05	Software for Server	1	set	3,165,480	3,165,480	Endless						
	TMP-GTS-06	Security Router	1	set	124,200	124,200	15			124,200			124,200
TMP-COS	TMP-COS-01	Operation PC	1	set	118,260	118,260	10		118,260		118,260		118,260
	TMP-COS-02	Software for PC	1	set	3,165,480	3,165,480	Endless						
	TMP-COS-03	Large Screen	1	unit	165,240	165,240	15			165,240			165,240
	TMP-COS-04	Printer	1	unit	105,300	105,300	15			105,300			105,300
	TMP-COS-05	Satellite Data PC	0	set	118,260	0	10		0		0		0
	TMP-COS-06	Software for PC	0	set	949,860	0	Endless						
	TMP-COS-07	UPS	2	unit	52,920	105,840	5	105,840	105,840	105,840	105,840	105,840	105,840
	TMP-COS-08	AVR	2	unit	42,120	84,240	15			84,240			84,240
	TMP-COS-09	Lightning Transformer	1	set	474,660	474,660	30						474,660
TMP-CMS	TMP-CMS-01	HF Radio for Voice	1	set	632,880	632,880	Transceiver 15 Antenna 30			316,440			632,880
	TMP-CMS-02	Antennea Tower	1	set	395,820	395,820	30						395,820
	TMP-CMS-03	Lightning Rod	1	set	79,380	79,380	30						79,380
	TMP-CMS-04	AVR	1	unit	42,120	42,120	15			42,120			42,120
MND-JNT	MND-JNT-01	Bubbler	1	set	374,760	374,760	15			374,760			374,760
	MND-JNT-02	GI Pipe	1	set	101,520	101,520	30						101,520
	MND-JNT-03	Orifice Tubing	1	set	42,660	42,660	15			42,660			42,660
	MND-JNT-04	Orifice Termination	2	pcs	10,800	21,600	15			21,600			21,600
	MND-JNT-05	Water Level Gauge	3	pcs	5,400	16,200	15			16,200			16,200
	MND-JNT-06	Weather Multisensor	1	set	248,400	248,400	10		248,400		248,400		248,400
	MND-JNT-07	Enclosure	1	set	146,880	146,880	30						146,880
	MND-JNT-08	Antenne Tower	1	set	395,820	395,820	30						395,820
	MND-JNT-09	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	MND-JNT-10	Lightning Rod	1	set	79,380	79,380	30						79,380
	MND-JNT-11	Lightning Arrester	4	pcs	12,960	51,840	10		51,840		51,840		51,840
	MND-JNT-12	Solar Module	2	pcs	85,320	170,640	30						170,640
	MND-JNT-13	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	MND-JNT-14	Battery	2	unit	84,780	169,560	5	169,560	169,560	169,560	169,560	169,560	169,560
	MND-JNT-15	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	MND-JNT-16	DCP Transmitter	1	set	264,060	264,060	15			264,060			264,060
MND-BZM	MND-BZM-01	Bubbler	1	set	374,760	374,760	15			374,760			374,760
	MND-BZM-02	GI Pipe	1	set	74,520	74,520	30						74,520
	MND-BZM-03	Orifice Tubing	1	set	21,060	21,060	15			21,060			21,060
	MND-BZM-04	Orifice Termination	2	pcs	10,800	21,600	15			21,600			21,600
	MND-BZM-05	Weather Multisensor	1	set	248,400	248,400	10		248,400		248,400		248,400
	MND-BZM-06	Enclosure	1	set	156,600	156,600	30						156,600
	MND-BZM-07	Antenne Tower	1	set	621,000	621,000	30						621,000
	MND-BZM-08	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	MND-BZM-09	Lightning Rod	1	set	79,380	79,380	30						79,380
	MND-BZM-10	Lightning Arrester	4	pcs	12,960	51,840	10		51,840		51,840		51,840
	MND-BZM-11	Solar Module	2	pcs	85,320	170,640	30						170,640
	MND-BZM-12	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	MND-BZM-13	Battery	2	unit	84,780	169,560	5	169,560	169,560	169,560	169,560	169,560	169,560
	MND-BZM-14	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	MND-BZM-15	DCP Transmitter	1	set	264,060	264,060	15			264,060			264,060
MND-CNC	MND-CNC-01	Operation PC	1	set	131,760	131,760	10		131,760		131,760		131,760
	MND-CNC-02	Software for PC	1	set	896,940	896,940	Endless						
	MND-CNC-03	Large Screen	1	unit	74,520	74,520	15			74,520			74,520
	MND-CNC-04	Monitoring PC	1	set	131,760	131,760	10		131,760		131,760		131,760
	MND-CNC-05	Printer	1	unit	105,300	105,300	15			105,300			105,300
	MND-CNC-06	UPS	2	unit	52,920	105,840	5	105,840	105,840	105,840	105,840	105,840	105,840
	MND-CNC-07	AVR	1	unit	42,120	42,120	15			42,120			42,120
	MND-CNC-08	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	MND-CNC-09	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	MND-CNC-10	HF Radio for Voice	1	set	632,880	632,880	Transceiver 15 Antenna 30			316,440			632,880
	MND-CNC-11	Antenne Tower	2	set	395,820	791,640	30						791,640
	MND-CNC-12	Lightnig Rod	2	set	79,380	158,760	30						158,760
	MND-CNC-13	Lightning Transformer	1	set	369,360	369,360	30						369,360
MND-SRN	MND-SRN-01	Speaker	12	unit	74,520	894,240	15			894,240			894,240
	MND-SRN-02	Speaker Driver	12	set	15,660	187,920	15			187,920			187,920
	MND-SRN-03	Controller	3	set	496,260	1,488,780	15			1,488,780			1,488,780
	MND-SRN-04	Diagnostic Circuit	3	set	18,360	55,080	15			55,080			55,080
	MND-SRN-05	Power Amplifier	6	unit	62,100	372,600	15			372,600			372,600
	MND-SRN-06	Enclosure	3	set	156,600	469,800	30						469,800
	MND-SRN-07	Siren Tower	3	set	459,000	1,377,000	30						1,377,000
	MND-SRN-08	Lightnig Rod	3	set	79,380	238,140	30						238,140
	MND-SRN-09	Lightning Arrester	6	pcs	12,960	77,760	10		77,760		77,760		77,760
	MND-SRN-10	Solar Module	6	pcs	85,320	511,920	30						511,920
	MND-SRN-11	Power Controller	3	unit	92,880	278,640	15			278,640			278,640
	MND-SRN-12	Battery	6	unit	84,780	508,680	5	508,680	508,680	508,680	508,680	508,680	508,680
	MND-SRN-13	HF Radio	3	set	613,980	1,841,940	Transceiver 15 Antenna 30			920,970			

Note: Full size table is attached as the Appendix of “Operation and Maintenance Manual for the GLOF and Rainstorm Flood Early Warning Systems (FEWS) in Mangdechhu and Chamkharchhu Basins, The Flood Monitoring and Command Room in NWFWC (August 2016)” prepared by the Project.

CHM-TSM	CHM-TSM-A-01	Anemometer Sensor	1	set	131,760	131,760	Out of coverage						
	CHM-TSM-A-02	Thermometer / Hygrometer	1	set	124,200	124,200	Out of coverage						
	CHM-TSM-A-03	Barometer	1	set	104,220	104,220	Out of coverage						
	CHM-TSM-A-04	Pyranometer	1	set	211,140	211,140	Out of coverage						
	CHM-TSM-A-05	Weight Type Rain Gauge	1	set	597,780	597,780	Out of coverage						
	CHM-TSM-A-06	Tipping Bucket Rain Gauge	1	set	64,260	64,260	15			64,260			64,260
	CHM-TSM-A-07	Enclosure	1	set	156,600	156,600	30						156,600
	CHM-TSM-A-08	Antenne Tower	1	set	395,820	395,820	30						395,820
	CHM-TSM-A-09	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	CHM-TSM-A-10	Lightning Rod	1	set	79,380	79,380	30						79,380
	CHM-TSM-A-11	Lightning Arrester	3	pcs	12,960	38,880	10		38,880		38,880		38,880
	CHM-TSM-A-12	Solar Module	2	unit	85,320	170,640	30						170,640
	CHM-TSM-A-13	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	CHM-TSM-A-14	Battery	2	unit	84,780	169,560	5	169,560	169,560	169,560	169,560	169,560	169,560
	CHM-TSM-A-15	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	CHM-TSM-A-16	DCP Transmitter	1	set	264,060	264,060	15			264,060			264,060
	CHM-TSM-A-17	UHF Radio	1	set	342,900	342,900	Transceiver 15 Antenna 30			171,450			342,900
	CHM-TSM-B-01	Bubbler with Temp Sensor	1	set	378,000	378,000	15			378,000			378,000
	CHM-TSM-B-02	GI Pipe	1	set	68,040	68,040	30						68,040
	CHM-TSM-B-03	Orifice Tubing	1	set	21,060	21,060	15			21,060			21,060
	CHM-TSM-B-04	Orifice Termination	2	pcs	10,800	21,600	15			21,600			21,600
	CHM-TSM-B-05	Water Level Gauge	3	pcs	5,400	16,200	15			16,200			16,200
	CHM-TSM-B-06	Tower B	1	set	65,340	65,340	30						65,340
	CHM-TSM-B-07	Enclosure	1	set	156,600	156,600	30						156,600
	CHM-TSM-B-08	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	CHM-TSM-B-09	Lightning Rod	1	set	63,180	63,180	30						63,180
	CHM-TSM-B-10	Lightning Arrester	3	pcs	12,960	38,880	10		38,880		38,880		38,880
	CHM-TSM-B-11	Solar Module	1	unit	85,320	85,320	30						85,320
	CHM-TSM-B-12	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	CHM-TSM-B-13	Battery	1	unit	84,780	84,780	5	84,780	84,780	84,780	84,780	84,780	84,780
	CHM-TSM-B-14	UHF Radio	1	set	342,900	342,900	Transceiver 15 Antenna 30			171,450			342,900
CHM-KGT	CHM-KGT-01	Bubbler	1	set	374,760	374,760	15			374,760			374,760
	CHM-KGT-02	GI Pipe	1	set	86,940	86,940	30						86,940
	CHM-KGT-03	Orifice Tubing	1	set	31,860	31,860	15			31,860			31,860
	CHM-KGT-04	Orifice Termination	2	pcs	10,800	21,600	15			21,600			21,600
	CHM-KGT-05	Water Level Gauge	3	pcs	5,400	16,200	15			16,200			16,200
	CHM-KGT-06	Weather Multisensor	1	set	248,400	248,400	10		248,400		248,400		248,400
	CHM-KGT-07	Enclosure	1	set	156,600	156,600	30						156,600
	CHM-KGT-08	Antenne Tower	1	set	395,820	395,820	30						395,820
	CHM-KGT-09	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	CHM-KGT-10	Lightning Rod	1	set	79,380	79,380	30						79,380
	CHM-KGT-11	Lightning Arrester	4	pcs	12,960	51,840	10		51,840		51,840		51,840
	CHM-KGT-12	Solar Module	2	pcs	85,320	170,640	30						170,640
	CHM-KGT-13	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	CHM-KGT-14	Battery	2	unit	84,780	169,560	5	169,560	169,560	169,560	169,560	169,560	169,560
	CHM-KGT-15	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	CHM-KGT-16	DCP Transmitter	1	set	264,060	264,060	15			264,060			264,060
CHM-KJY	CHM-KJY-A-01	Bubbler	1	set	374,760	374,760	15			374,760			374,760
	CHM-KJY-A-02	GI Pipe	1	set	130,140	130,140	30						130,140
	CHM-KJY-A-03	Orifice Tubing	1	set	21,060	21,060	15			21,060			21,060
	CHM-KJY-A-04	Orifice Termination	2	pcs	10,800	21,600	15			21,600			21,600
	CHM-KJY-A-05	Enclosure	1	set	156,600	156,600	30						156,600
	CHM-KJY-A-06	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	CHM-KJY-A-07	Lightning Arrester	0	pcs	12,960	0	10		0		0		0
	CHM-KJY-A-08	UHF Radio	1	set	342,900	342,900	Transceiver 15 Antenna 30			171,450			342,900
	CHM-KJY-B-01	Weather Multisensor	1	set	248,400	248,400	10		248,400		248,400		248,400
	CHM-KJY-B-02	Enclosure	1	set	156,600	156,600	30						156,600
	CHM-KJY-B-03	Antenne Tower	1	set	395,820	395,820	30						395,820
	CHM-KJY-B-04	Data Logger	1	set	369,360	369,360	15			369,360			369,360
	CHM-KJY-B-05	Lightning Rod	1	set	92,880	92,880	30						92,880
	CHM-KJY-B-06	Lightning Arrester	4	pcs	12,960	51,840	10		51,840		51,840		51,840
	CHM-KJY-B-07	Solar Module	2	pcs	85,320	170,640	30						170,640
	CHM-KJY-B-08	Power Controller	1	unit	92,880	92,880	15			92,880			92,880
	CHM-KJY-B-09	Battery	2	unit	84,780	169,560	5	169,560	169,560	169,560	169,560	169,560	169,560
	CHM-KJY-B-10	DCP Transmitter	1	set	264,060	264,060	15			264,060			264,060
	CHM-KJY-B-11	UHF Radio	1	set	342,900	342,900	Transceiver 15 Antenna 30			171,450			342,900
CHM-CNC	CHM-CNC-01	Operation PC	1	set	131,760	131,760	10		131,760		131,760		131,760
	CHM-CNC-02	Software for PC	1	set	896,940	896,940	Endless						
	CHM-CNC-03	Large Screen	1	unit	74,520	74,520	15			74,520			74,520
	CHM-CNC-04	Monitoring PC	1	set	131,760	131,760	10		131,760		131,760		131,760
	CHM-CNC-05	Printer	1	unit	105,300	105,300	15			105,300			105,300
	CHM-CNC-06	UPS	2	unit	52,920	105,840	5	105,840	105,840	105,840	105,840	105,840	105,840
	CHM-CNC-07	AVR	1	unit	42,120	42,120	15						
	CHM-CNC-08	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	CHM-CNC-09	HF Radio	1	set	613,980	613,980	Transceiver 15 Antenna 30			306,990			613,980
	CHM-CNC-10	HF Radio for Voice	1	set	632,880	632,880	Transceiver 15 Antenna 30			316,440			632,880
	CHM-CNC-11	Antenne Tower	1	set	395,820	395,820	30						395,820
	CHM-CNC-12	Lightnig Rod	1	set	79,380	79,380	30						79,380
	CHM-CNC-13	Lightning Transformer	1	set	369,360	369,360	30						369,360
CHM-SRN	CHM-SRN-01	Speaker	24	unit	74,520	1,788,480	15			1,788,480			1,788,480
	CHM-SRN-02	Speaker Driver	24	set	15,660	375,840	15			375,840			375,840
	CHM-SRN-03	Controller	6	set	496,260	2,977,560	15			2,977,560			2,977,560
	CHM-SRN-04	Diagnostic Circuit	6	set	18,360	110,160	15			110,160			110,160
	CHM-SRN-05	Power Amplifier	12	unit	62,100	745,200	15			745,200			745,200
	CHM-SRN-06	Enclosure	6	set	156,600	939,600	30						939,600
	CHM-SRN-07	Siren Tower	6	set	459,000	2,754,000	30						2,754,000
	CHM-SRN-08	Lightnig Rod	6	set	79,380	476,280	30						476,280
	CHM-SRN-09	Lightning Arrester	12	pcs	12,960	155,520	10		155,520		155,520		155,520
	CHM-SRN-10	Solar Module	12	pcs	85,320	1,023,840	30						1,023,840
	CHM-SRN-11	Power Controller	6	unit	92,880	557,280	15			557,280			557,280
	CHM-SRN-12	Battery	12	unit	84,780	1,017,360	5	1,017,360	1,017,360	1,017,360	1,017,360	1,017,360	1,017,360
	CHM-SRN-13	HF Radio	6	set	613,980	3,683,880	Transceiver 15 Antenna 30			1,841,940			3,683,880
Total								2,776,140	5,091,660	27,083,430	5,091,660	2,776,140	50,545,080
Grand Total													93,364,110
Average Yearly Cost : Grand Toatl / 30													3,112,137

4) Accomplishment and Remaining Challenge on Capacity Development

Hydrology division staff in DHMS, operators of flood monitoring/command room in NWFWC and operators of both control rooms in the basins demonstrated that they have developed enough capacity for the EWS daily operation through trainings based on the O/M Manual and operating experience since November 2015.

However, their capacity for information sharing service, post handling of false alarm, and responding to malfunction needs more development through practical experience on operation/maintenance and periodic flood mock drills.

4.4 Achievements on Output 3 Activities

All the Project activities on Output 3 “Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins” in the 2nd Phase (September 2015 - September 2016) are described in this section.

4.4.1 Plan and Conduct Evacuation Drill in the Pilot Basins (Activity 3-3)

In Bjizam, Wangdicholing and Chamkhar Town communities, flood warning evacuation plans which were formulated by July 2015 were updated and reviewed. At Gangrithang and Chokhortoe Primary Schools, existing school disaster management plans were reviewed and updated to include flood evacuation procedures. In the three communities and two schools, evacuation drills were conducted as the final product of the activities. Follow-up meetings on the awareness-raising plans which were formulated by July 2015 were held at Chokhortoe surrounding communities, Kurjey and Gyelkhar/ Gongkhar communities.

1) Flood Warning Evacuation Planning Workshop

The flood warning evacuation plans were updated and reviewed with the representatives of the communities in the following communities: Bjizam (November 19th, 2015 and February 25th, 2016), Wangdicholing (November 16th, 2015 and February 29th, 2016) and Chamkhar Town (November 14th, 2015 and March 14th, 2016). The C/Ps from DHMS, District (District Disaster Management Officer), Mayor of Chamkhar Town and Gewog (Gewog Administrative Officer) also took the roles as facilitators with the JICA Expert Team. The following activities were undertaken in the workshops:

- Review and update of flood warning evacuation plans (vulnerable households, evacuation routes, evacuation procedures, evacuation places, roles and responsibilities of evacuation management teams)
- Selection of evacuation management team members
- Establishment of communication flow between district and communities/ schools and within the evacuation management team during emergencies
- Training for evacuation management team members

Bjizam community


Wangdicholing community


Chamkhar Town

2) Revision of Existing School Plan Workshop

The workshops were held on November 14th, 2015 and March 9th to 11th, 2016 at Gangrithang Primary School to discuss the evacuation place and roles and responsibilities of teachers. In Chokhortoe Primary School, the workshops were held on November 13th, 2015 and March 5th, 2016. The following topics were covered:

a. Validation and update of the hazard map;
b. Selection of safe evacuation place and evacuation route;
c. Formulation of evacuation procedure;
d. Enumeration of roles and responsibilities of teachers; and
e. Formulation of action plan


Gangrithang Primary School


Chokhortoe Primary School

In the three communities and two schools, discussion on equipment which would be needed for evacuation also was held. The contents were also discussed with C/Ps and finalized as shown in Table 4.10. The equipment was handed over to the communities and schools and training on use of the equipment was given to the team members and teachers.

Table 4.10 Evacuation Equipment List

Equipment	Community				
	Bjizam	Wangdicholing	Chamkhar Town	Gangrithang Primary School	Chokhortoe Primary School
Megaphone	3	4	5	4	3
Head lamp	10	10	8	8	10
Reflectorized vest	10	10	8	20	20
Stretcher	3	3	2	3	2

Equipment	Community				
	Bjizam	Wangdicholing	Chamkhar Town	Gangrithang Primary School	Chokhortoe Primary School
First Aid Kit	3	3	2	2	3
Tarpaulin	2	2	6	6	5
Rope	2	2	6	6	5

3) Awareness-raising Planning Workshop

The follow-up meetings on awareness-raising plans were held in Kurjey (Dawathang, Pangrey and Dorjibee groups) on November 14th, 2015, in surrounding communities of Chokhortoe Primary School on November 13th, 2015 and in Gyelkar/Gongkhar on November 18th, 2015. In the meetings, it was confirmed that the awareness-raising sessions on the EWS system were successfully conducted for the rest of the community people multiple times in all of the communities.

In the meetings at Kurjey and Chokhortoe surrounding area, participants requested the Project to conduct evacuation drills at their communities. After discussion, it was decided to invite representatives of Kurjey and Chokhortoe surrounding communities to evacuation mock drills at Wangdicholing community and Chokhortoe Primary School, respectively. The representatives of Gyelkhar/ Gongkhar communities decided that people who are located near the river would voluntarily evacuate when they hear the siren, and the community would select evacuation supporting volunteers. The volunteers were selected in June of 2016, after the new mayor was elected.

Kurjey community

Chokhortoe Primary School

Gyelkhar/Gongkhar community

Table 4.11 shows the number of participants in the CBDRM workshops.

Table 4.11 Number of Participants in CBDRM Workshops

Community	Date (YYYY/MM/DD)	Workshop Participants						Affected Population	
		Total	Central		District	Gewog/ Tromde	Community	Directly Affected	Indirectly Affected
			DHMS	DDM					
Flood Warning Evacuation Planning Workshop									
Wangdicholing	2015/11/16	12			1		11	74	300
	2016/02/29	10	2		1		7		
Bjizam	2015/11/19	15			1		14	51	150
	2016/02/25	18	2		1		15		
Chamkar Town	2015/11/14	14			1		13	580	1,000
	2016/03/14	103	1		1	2	99		
Integration of Existing Flood Evacuation Planning Workshop									
Gangrithang Primary School	2015/11/14	19	1			1	17	300	600
	2016/03/9-11	20	2		1		17		
Chokhortoe Primary School	2016/11/13	13	1		1		11	600	200
	2016/03/05	11	2		1	1	7		
Follow-up Meeting on Awareness-raising Plan									
Kurjey	2015/11/14	7	1			1	5	440	500
	2016/03/05	34	2		1	1	30		
Chockhortoe (Activity of the surrounding communities)	2015/11/13	8	1		1		6	Same as Chokhortoe Primary School	
	2016/03/07	16	2		1	1	12		
Gyelkar/ Gongkar	2015/06/18	14			1		13	100	200
	2016/03/08	28	2		1		25		
Total		342	19		14	7	302	2,145	2,950

4) Conduct of Evacuation Mock Drill

The evacuation mock drill was conducted on March 1, 2016 at Wangdicholing community where 49 people participated. Six (6) representatives from Kurjey community observed the mock drill. At Kurjey community, a presentation on the mock drill was held for the rest of the community on March 5th, 2016. At Chokhortoe Primary School, the mock drill was conducted on March 7th, 2016; 96 students and 9 teachers participated. Twelve community representatives from the surrounding communities observed the drill. On March 12th, 2016, Gangrithang Primary School conducted the mock drill; 282 students and 19 teachers participated. In the mock drill, the Governor of Bumthang District, Director of DDM, two (2) DDM staff and four (4) DHMS staff participated as observers. On March 15th, evacuation mock drill was conducted in Chamkhar Town where 183 people participated. The Governor of Bumthang District observed the drill. At Bjizam, the drill was conducted on March 16th, 2016; 48 people participated. In all the communities and schools, C/Ps from the central, district and/ or Gewog levels participated. They worked actively with community people from the preparation phase to de-briefing sessions which were conducted after mock drills. Table 4.12 shows the number of participants to the mock drills.

Table 4.12 Number of Participants in Evacuation Mock Drill

Community	Date (YYYY/MM/DD)	Community	DHMS	DDM	District	Gewog/ Tromde	Other Community
Wangdicholing	2016/03/01	49	2		1	1	6
Chokhortoe Primary School	2016/03/07	105	2		1	1	12
Gangrithang Primary School	2016/03/12	301	4	3	2		
Chamkhar Town	2016/03/15	183	1	1	2	2	
Bjizam	2016/0316	48	1			1	

Wangdicholing Community Evacuation Mock Drill

Chokhortoe Primary School Evacuation Mock Drill

Gangrithang Primary School Evacuation Mock Drill

Chamkhar Town Community Evacuation Mock Drill

Bjizam Community Evacuation Mock Drill

4.4.2 SOP on Emergency Information Sharing in the Basins (Activity 3-4)

1) Basic Concept of SOP in the Basins

Flood early warning as well as emergency response should be completed in the basin under the initiative of Dzongkhag Emergency Operation Center (Dzongkhag EOC) and Dzongkhag Disaster Management Officer (DDMO). The newly established Control Center is the only provider of river related information in the basin. Therefore, strengthening the emergency communication between the Control Center and Dzongkhag is very important.

The SOP was formulated between DHMS and the Expert Team according to the following concepts:

Concept of SOP in the basins

- *The SOP does not cover entire emergency response in Dzongkhag disaster management, but guides emergency communication on river related information between the information provider and Dzongkhag administrator.*
- *The SOP shall be a reference of Dzongkhag Contingency Plan stipulated in Disaster Management Act in future.*

Role of Control Center

- *The Control Center is just an information provider, not a decision maker.*
- *To avoid confusion in emergency situation, information access to the Control Center from outside (officials and individuals) should be minimized*

2) Workshops on SOP in the Basin

Stakeholder meetings in Trongsa and Bumthang were held on February 26 and 29, 2016 to discuss the basic concept of the SOP. Members of Dzongkhag disaster management committee (governor, vice governor, Dzongkhag officers, police, representative of monks), Mangdechhu Hydro Power Authority (MHPA), Bumthang Airport, principals of primary schools, DHMS and DDM staff participated in the meetings. In the meetings, evacuation planning and drills were reviewed and information sharing schemes were actively discussed among the stakeholders.

MHPA is one of the most important stakeholders in the Mangdechhu river basin. In order to introduce the EWS to MHPA administrators and construction workers in the site, a technical workshop was held on June 3, 2016. Since the EWS is valuable for MHPA in view of safety management of dam construction as well as dam operation after the construction, many technical advices and suggestions were raised in the workshop. Practical suggestions such as call-off process of error warning are very important to improve the SOP.

Stakeholder Meeting
in Trongsa

Stakeholder Meeting
in Bumthang

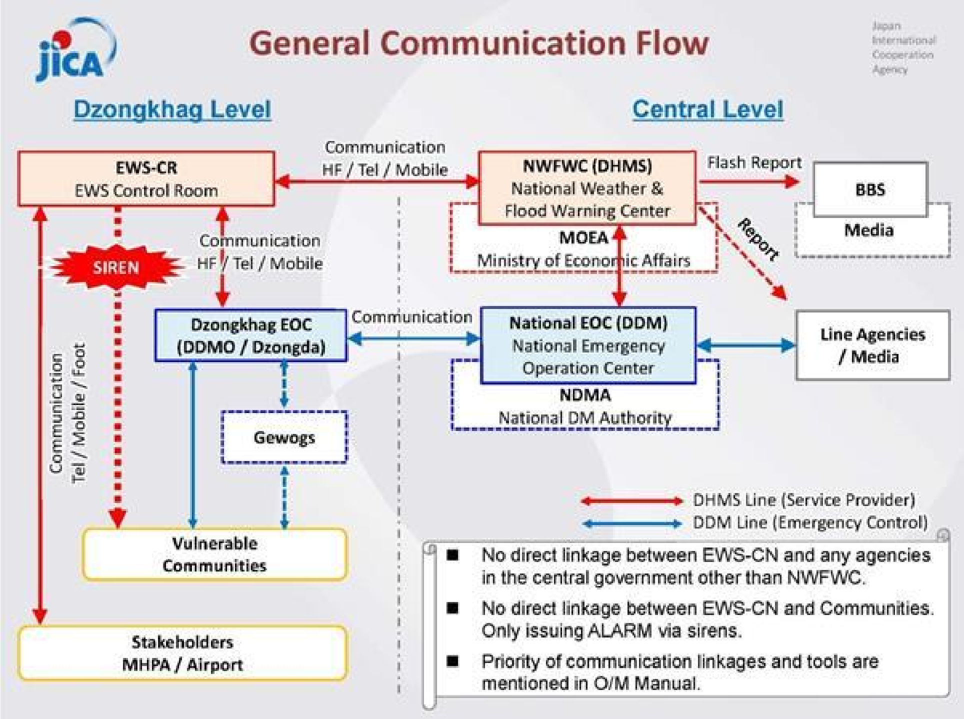
SOP Workshop in MHPA

3) Formulation of SOP in the Basin

Considering suggestions from stakeholders, the general communication flow in SOP was prepared as shown in Figure 4.5.

Key points of the communication flow are 1) no direct communication between the Control Center and any agencies in the central government other than NWFWC and 2) no direct communication between the Control Center and vulnerable communities in order to minimize the access to the Control Center. By way of exception, however, MHPA in the Mangdechhu river basin and Airport in the Chamkharchhu river basin can communicate with the Control Center because timely information is essential for these stakeholders.

The general communication flow and practical procedure for information sharing were introduced to the relevant agencies in the project final seminar.



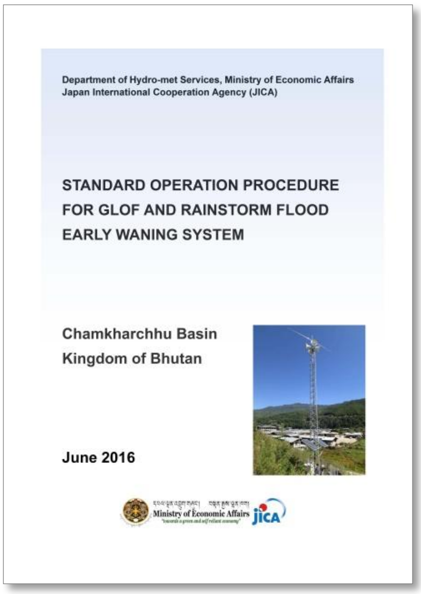
- No direct linkage between EWS-CN and any agencies in the central government other than NWFWC.
- No direct linkage between EWS-CN and Communities. Only issuing ALARM via sirens.
- Priority of communication linkages and tools are mentioned in O/M Manual.

Figure 4.5 Basic Information Flow in the SOP

DHMS and the Expert Team conducted field survey and interview in the Dzongkhags and communities after the serious flood disaster on July 2016 in order to reflect the real experience in the SOP.

In Bumthang, the governor directly instructed information collection and evacuation of local residents during the flood. In the current situation that the Dzongkhag EOC has not been established, such strong initiative of the governor was effective in emergency situation. Further, it was realized that the mobile communication was still effective for evacuation direction in addition to the warning siren unless there is a network shutdown. On the other hand, in Trongsa, MHPA requested DHMS to review the Alert and Alarm levels based on the experience of the flood.

Considering the above lessons learned, the SOP were modified and finalized by DHMS and the Expert Team. The SOP shall be continuously revised by DHMS and DDM adjusting with the Dzongkhag Contingency Plan after the Project.


Department of Hydro-met Services, Ministry of Economic Affairs
Japan International Cooperation Agency (JICA)

STANDARD OPERATION PROCEDURE
FOR GLOF AND RAINSTORM FLOOD
EARLY WANING SYSTEM

Chamkharchhu Basin
Kingdom of Bhutan

June 2016

Ministry of Economic Affairs

SOP in the Chamkharchhu Basin

Chapter 5 Change in Counterpart State by Technical Transfer

The C/P state such as awareness and capacity by the technical transfer was greatly enhanced through the Project activities for three (3) years from the kick-off in September 2013 to the Project completion in September 2016 as shown in Table 5.1.

Table 5.1 Change in C/P State by Technical Transfer

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
Output 1	Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.		
1-1	Analysis of present state of NWFWC on existing hydro-met data, monitoring and warning	100	<July 2015> No particular technical transfer is included in this activity, since the main C/P's activities are the collaborative work such as provision of information with the JICA Expert Team who analyzed the present status. As for the GTS installation, the C/P's assisted the coordination with related international agencies.
1-2	Installation of necessary facilities to develop integrated platform and beginning its operation	50	<September 2014> DHMS's proactive and positive participation to the activity has always been very high from the kick-off till present. For the GTS installation, DHMS C/Ps participated actively in the provision of information, discussion, and coordination with related agencies with the JICA Expert Team.
		70	<July 2015> With the continuous proactive involvement, the C/P's assisted the JICA Contractor during the GTS installation work. The C/P prepared the GTS O/M manual with the JICA Expert.
		100	< March 2016> With the continuous proactive involvement, the C/P assisted in the GTS installation work and participated in the GTS O/M manual preparation and trainings. As a final output, DHMS started 24/7 GTS operation by March 2016.
1-3	Run-off and flood analyses based on potential GLOF and climate change	0	<October 2013> As for flood risk analysis and hazard map preparation, several C/P agencies conducted activity independently without clear demarcation between agencies, information sharing and coordinating mechanism to discuss related issues.
		90	<September 2014> Flood Hazard Map working group (FHM W/G) was organized with all the C/P agencies (DHMS, DDM, DGM, DoES, NLCS and DHS) as members to meet and discuss periodically. Daily activities and trainings have been planned and conducted

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
			based on the discussion in FHM W/G workshops. As a result, related C/P agencies became capable to promote the activity with clearer demarcation and smooth information sharing that resulted from the interaction in the W/G. The C/Ps now have more incentive to join the activity.
		100	<July 2015> All the activities were completed, as scheduled, because of the continuation of the favorable condition described above.
1-4	Discussion to enhance coordination between GLOF/ flood risk assessment sector and development sector	0	<October 2013> No C/P agencies had particular awareness on MDRR excluding DDM in charge of disaster management administration. Even though Disaster Management Act enacted in 2013 clearly declared MDRR in all the sectors and agencies, there was no mechanism and opportunity for the C/P agencies to discuss and coordinate on MDRR.
		50	<September 2014> Similar to FHM W/G mentioned above, MDRR W/G was organized for all the six C/P agencies to meet and discuss periodically. Activities have been planned and conducted through the W/G workshops. As a result of free discussion in the series of workshops, all the C/P agencies started to have common understanding of MDRR issues on institution and related disaster management subjects and their future conceivable solutions. The motivation of each C/P agency on the promotion of MDRR has been strengthened greatly.
		80	<July 2015> The good coordination through the W/G will be developed into the Inter-Ministerial Task Force stipulated in Disaster Management Act 2013 even after the completion of the Project
		100	<July 2016> All the activities were completed, as scheduled, because of the continuation of the favorable condition described above.
1-5	Preparation and improvement of hazard map through training for relevant agencies	0	<September 2014> No activity
		50	< July 2015> The activity has started based on the favorable coordination through the W/G formulated in Activity 1-3. The W/G will be developed into the Inter-Ministerial Task Force stipulated in Disaster Management Act 2013 even after the completion of the Project

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
		100	<August 2016> All the activities completed, as scheduled, because of the continuation of the favorable condition described above.
1-6	Awareness raising in relating agencies on land use management against disaster	0	<October 2013> Some C/P agencies had the awareness on land use management for disaster separately. For example, the DHS formulated the Bumthang master plan while the NLCS was in charge of land use regulation. The awareness of the C/P agencies was not so high, since there was no mechanism for the C/P agencies to exchange information, discuss and coordinate on this issue.
		30	<September 2014> The W/G formulated in Activity 1-4 has also conducted these activities with the regular W/G members, since the land use issue is very much related to MDRR. As a result of the discussion and information sharing based on the presentation of particular examples by each participant in the workshop, all the C/P agencies started to have common understanding of land use issues to promote future action planning activities.
		100	<July 2015> The good coordination through the W/G will be developed into Inter-Ministerial Task Force stipulated in Disaster Management Act 2013 even after the completion of the Project.
1-7	Proposal of institution and legal system necessary for mainstreaming disaster risk assessment into development plan	0	<September 2014> No activity
		30	<July 2015> With the high awareness of DDM after the big earthquake in Nepal on April 25, 2015, the joint analysis of present status and issues on the disaster management system in Bhutan was smoothly implemented.
		100	<June 2016> The W/G formulated in Activity 1-4 has also conducted this activity with the regular W/G members, since the institutional issue is very much related to MDRR. As a result of the discussion and information sharing based on the presentation by each participant in workshop, all the W/G members now share a common understanding that Inter Ministerial Task Force stipulated in DM Act 2013 will be the appropriate institution for the purpose.

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
1-8	Improvement of flood and weather forecasting system utilizing numerical weather prediction data (GPV) by use of accumulated hydro-meteorological data	0	<September 2014> No activity
		25	<July 2015> The awareness of the C/P was increased after participating at the C/P training on SATAID in Japan in November 2014. The activities on the preparation of manuals and training have been implemented smoothly after May 2015 with active involvement of the C/P.
		100	<June 2016> As the awareness of the C/P increased after the commencement of the GTS and HimawariCast operation in March 2016, all the training activities using the equipment were completed as planned.
1-9	Development of SOP on emergency information sharing through discussion and workshop with relevant agencies	0	<July 2015> No activity
		100	<August 2016> The W/G formulated in Activity 1-4 has also conducted this activity with the regular W/G members, since the institutional issue is very much related to MDRR. As a result of the discussion and information sharing based on the presentation by each participant in workshop, the SOP was smoothly developed.
Output 2	Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.		
2-1	Analysis of current condition and extraction of issue on existing meteorological and hydrological observation network and proposed water power plant	100	<September 2014> No particular technical transfer is included in this activity, since the main C/P's activities were the collaborative work such as provision of information and joint field reconnaissance with the JICA Expert Team who analyzed the present status.
2-2	Collecting and analyzing fundamental information for design of early warning system in basins	100	<September 2014> DHMS showed high initiative for the activity from the beginning in October 2013, since they already have the experiences in EWS installation, operation and maintenance, and SOP preparation in adjacent river basins supported by UNDP. The main C/P's activities were the provision of information, discussion, joint field reconnaissance, coordination with related agencies including land allocation and preparation of EWS technical specification by JICA Expert Team.
2-3	Distribution plan and specification of EWS in pilot basins	100	
2-4	Installation of equipment and facilities in pilot basins and NWFWC	20	<September 2014> As described above, DHMS showed high initiative for the activity. The main C/P's activity was the active support for the preparatory civil works conducted by the JICA Expert Team

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
		80	<July 2015> DHMS's proactive and positive participation on the activities were always very high. They dispatched many staff, at its own expense, to assist the field EWS installation work such as the preliminary field survey in October 2014 and the EWS installation work in May – June 2015 by JICA Contractor with JICA Expert Team.
		100	<March 2016> With the continuous proactive involvement, DHMS dispatched many staff, at its own expense, to assist the field EWS installation work for several months in September - October 2015 and February - March 2016. <u>As a final output, DHMS started 24/7 EWS operation in May 2016.</u>
2-5	Preparation of Manual for EWS operation and maintenance and training for central and local DHMS staff	0	<September 2014> No activity
		40	<July 2015> As described in Activity 2-3, DHMS showed high initiative for the activity. Therefore, the C/P actively participated in the O/M manual preparation and the training with the JICA Expert.
		100	<June 2016> All the activities were completed as scheduled because of the continuation of the favorable condition described above. <July 2016> <u>Because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level at 1:30 AM on July 26. After that, NWFWC and EWS control room staff operated the EWS appropriately during flood using the O/M manual.</u>
Output 3	Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.		
3-1	Holding workshops to review flood emergency response on warning and evacuation in the pilot basins	100	<September 2014> DHMS and DDM proactively participated in the kick-off workshops held in the pilot project area. <March 2015> A series of workshops were successfully completed with the better-than-expected proactive participation from district focal person, target communities and schools. DHMS C/P joined the field workshops with JICA Experts for a significant period of time, however, the involvement of DDM C/P was not so high.
3-2	List target communities and examine flood warning criteria in pilot basins	100	
3-3	Plan and conduct warning and evacuation drills as	0	<September 2014> No activity

No.	Activities	Progress Ratio (%)	Change in C/P (such as awareness and capacity)
	well as EWS operation drill in the pilot basins	60	<July 2015> With the continuation of favorable condition described in activity 3-2, evacuation planning for target communities and schools was almost completed. DHMS C/P joined the field workshops. However, no participation from DDM.
		100	<March 2016> With the continuation of favorable condition described above, evacuation drills for target communities and schools were successfully implemented with the cooperation of DDMO. DHMS and DDM C/P joined the drills. The footage of the drill was repeatedly broadcasted by BBS. <July 2016> Because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level at 1:30 AM on July 26. Upon hearing the siren, all the vulnerable community people evacuated to the safe evacuation place as planned and trained.
3-4	Develop SOP for GLOF/rainstorm flood in pilot basins	0	<July 2015> No activity
		80	<June 2016> DHMS C/P and various stakeholders including District Governors in the pilot basins were actively involved in the preparation of draft SOP through discussion and workshops.
		100	<August 2016> In the evacuation directive in July 2016 monsoon flood, Bumthang District Governor took an important part by communicating relevant agencies. The Governor presented important recommendation in finalizing the SOP based on his experience during the flood.

Chapter 6 Achievement of the Project Purpose

Through the activities of the three Outputs, the capacity of the DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood has been surely enhanced. The Project outputs and purpose described in the PDM (refer to Appendix 2) were completely achieved at the Project completion in August 2016, three years after the commencement of the Project in September 2013.

In the extra ordinary continuous monsoon rain in late July 2016,all the EWS warning sirens installed along the Chamkharchhu basin were activated when the water level reached the Alarm Level at 1:30 AM on July 26. Immediately after, all the vulnerable community people evacuated to the safe evacuation place as planned and trained by the Project. This perfect functioning of the Outputs of the Project activities from the hardware (the operation of the flood EWS) to the software (the evacuation of the target community people) during real flooding verified the high achievement of the Project output and purpose.

6.1 Achievements of Outputs

As shown in Table 6.1, the three Outputs described in the PDM (refer to Appendix 2) were totally achieved at the Project completion in September 2016, since DHMS's proactive and positive participation in the activities have been always very high.

Table 6.1 Achievement of the Project Outputs

Outputs in PDM	Objectively Verification Indicators in PDM	Achievement as of August 2016	Notes
1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Plan of institutional strengthening for mainstreaming disaster risk assessment information into development plans is formulated.	100%	The baseline survey on related agencies was completed in December 2013. Related issues such as the establishment of the Inter Ministerial Task Force in the Disaster Management Act 2013 were discussed in the Mainstreaming Disaster Risk Reduction Working Group from February 2014 to August 2016.
	b. Equipment and facilities for NWFWC are installed as scheduled and utilized as planned.	100%	The specification document on the equipment (GTS/MSS) was completed in Jul 2014. A JICA contractor was officially selected in August 2014. The installation work started in May 2015 and completed in March 2016. DHMS started 24/7 operation since March 2016. GTS O/M manual was prepared and the trainings were conducted from April 2015 to April 2016.

Outputs in PDM	Objectively Verification Indicators in PDM	Achievement as of August 2016	Notes
	c. GLOF/rainstorm flood risk zonation maps are developed.	100%	The zonation map was finalized in November 2015 through Flood Hazard Map Working Group. The trainings using the map preparation manual were conducted in November 2015. The map preparation in other river basin (Thimphuchhu) and the trainings were conducted in March - July 2016.
	d. Flood and weather forecasting is delivered daily by utilizing improved forecasting system.	100%	The C/P training in Japan on SATAID was conducted in November 2014. The installation of GTS/MSS and HimawariCast receiver was completed in March 2016. DHMS started 24/7 weather forecasting and its delivery in March 2016. The weather forecasting manual was prepared and the trainings were conducted from May 2015 to June 2016.
	e. SOP on emergency information sharing is developed	100%	The SOP was discussed and developed in the Mainstreaming Disaster Risk Reduction Working Group in June and August 2016.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned.	100%	The specification document on the equipment was completed in July 2014. A JICA contractor was officially selected in Aug 2014. The installation work started in May 2015 and completed in March 2016. DHMS started 24/7 operation in May 2016. At 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated automatically as planned and designed upon the water level reaching the Alarm Level.
	b. EWS operation and maintenance manual is developed.	100%	The manual was developed from April 2015 to June 2016.
	c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	100%	The trainings were conducted from June 2015 to June 2016 based on the manual mentioned above. At 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level. After that, NWFWC and EWS control room staff

Outputs in PDM	Objectively Verification Indicators in PDM	Achievement as of August 2016	Notes
			operated the EWS appropriately during flood using the O/M manual.
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts.	100%	DDM, DHMS and district office held a series of workshops at the target communities and schools in 2 pilot river basins in September - October. 2014 and March 2015.
	b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins.	100%	The plan formulation workshops were held in June 2015 to February 2016. The evacuation drills were conducted in March 2016. At 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level. Immediately after, all the vulnerable community people evacuated to the safe evacuation place as planned and trained.
	c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	100%	SOP was developed through the discussion and workshops in the pilot basins in February and June 2016.

6.2 Achievement of the Project Purpose

As shown in Table 6.2, the Project Purpose described in the PDM (refer to Appendix 2) were totally achieved at the Project completion in September 2016.

Table 6.2 Achievement of the Project Purpose

Project Purpose in PDM	Objectively Verification Indicators in PDM	Achievement as of August 2016	Notes
Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP).	100%	The EWS, the GTS/MSS and the HimawariCast receiving system were installed in March 2016 to enhance the capacity of the DHMS on weather and flood forecasting and early warning. DHMS staff have been trained on the systems, and the training was provided and relevant manuals were finalized in June 2016. DHMS started 24/7 system operation since May 2016 according to the SOP. The SOPs at central and local levels were finalized in July 2016.

Project Purpose in PDM	Objectively Verification Indicators in PDM	Achievement as of August 2016	Notes
			After that, at 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level. After that, NWFWC and EWS control room staff operated the EWS appropriately during flood using the O/M manual and communicate with Bumthang District Office and DDM according to the SOP. That appropriate procedure resulted in the safety evacuation of the target community people.
	b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	100%	Since the EWS operation and evacuation drills were conducted for the first time at the time of the terminal evaluation as originally planned, it is difficult to verify the regular implementation of the drills. The target communities, however, were committed to the CBDRM activities including the preparation for the drills. Additionally, the DDM plans to incorporate the evacuation plans including a regular drill into the DDMP for Bumthang. Hence these achievements suggest that the drills in the pilot river basins will be conducted regularly. At 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level. Immediately after, all the vulnerable community people evacuated to the safe evacuation place as planned and trained. As a result of conducting the real evacuation action, the awareness of the relevant agencies and the target community people has highly increased. Their motivation to conduct periodical evacuation drill and the revision of evacuation plan in future is judged high enough.

Chapter 7 Issues and Lessons Learned

7.1 GTS/MSS and EWS Installation

The installation of the equipment for the GTS/MSS in NWFWC and the EWS for two pilot river basins were initially planned to be completed in May 2015. However, the installation work was delayed and completed in March 2016. Accordingly, the Project objective achievement on this output has fallen short of expectations. The initial installation schedule should have been examined more carefully, since the installation is the critical area of the overall Project progress.

The related Project activity schedule such as the GTS/MSS and EWS manual preparation and training was reviewed and postponed reflecting this delay. As a result, it was confirmed that the influence of the delay to the related activities was limited and the activities were successfully conducted in the 2nd Phase (October 2015 – August 2016) without significant schedule change.

7.2 Overall Activities

Overall Project activities other than 1) mentioned-above implemented smoothly almost as planned with the positive and independent participation of all the counterpart agencies. Accordingly, it is judged that the Project Purpose was satisfactorily achieved as described in the previous chapter. The achievement of the Project Purpose was also verified visually through the implementation of the flood EWS operation, the activation of all the warning sirens and the evacuation from all the target vulnerable communities in Chamkharchhu basin during July 2016 monsoon flooding.

Communication between the JICA Expert Team and their counterparts has been very good. The DHMS made sure that most JICA experts occupied the same office space with his/her DHMS counterparts. This office arrangement worked well to ensure communication between them.

The capacity development of DHMS has been achieved effectively because of their high motivation and initiative in not only daily Project activities in Thimphu but also field activities in the two pilot river basins. What is effective for the remarkable technical transfer and capacity development of the counterpart is that DHMS dispatched a total of 16 staff to the Pilot Project Areas for several months, at its own expense, to assist the EWS installation work by JICA Contractor with the cooperation of the JICA Expert Team.

The participation of five sub-counterpart agencies, DDM, DGM, DoES, NLCS and DHS to the Project activity is also very positive and active. The coordination between the counterpart agencies has been strengthened through periodical Working Group Workshops especially the flood hazard mapping and mainstreaming disaster risk reduction working groups. These effective working group activities will strongly be promoted sustainably. With the introduction of the Working Group mechanism, it is decided that the Working Groups will be elevated into Inter-Ministerial Task Force stipulated in Disaster Management Act 2013 after the completion of the Project. The Task Forces for other disasters such as earthquake, landslide and fire will be organized by reference to the Working Group of the Project.

7.3 DDM/ DHMS Support for District Government on EWS Sensitization

At 1:30 AM on July 26, 2016, because of the extra ordinary continuous monsoon rain, all the EWS warning sirens along the Chamkharchhu were activated upon the water level reaching the Alarm Level. Immediately after, all the vulnerable community people evacuated to the safe evacuation place as planned and trained. However, the people who inhabited the safe area outside the flood risk area got panics and evacuated after listening the siren sound, since the siren sound reached very far than expected and they were not informed about the EWS at all.

The important lessons learned from the series of events happened in the July 26, 2016 flood is the importance and necessity of further and continuous sensitization by Bumthang District Office on the EWS installed by the Project, which will not only be the periodical evacuation mock drill at vulnerable communities but also the general awareness raising for other general public inhabited in entire Bumthang valley.

In this context, it was agreed by DDM and DHMS to support Bumthang District Office financially and technically for their future sensitization activities.

Chapter 8 Recommendations to Achieve Overall Goal

The Overall Goal of the Project (to be achieved 3 to 5 years after this Project completion) and the Objectively Verifiable Indicators are described in the Project Design Matrix (PDM) (refer to Appendix 2) as follows:

Overall Goal: Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.

Objectively Verifiable Indicator a : GLOF/rainstorm flood forecasting and early warning is properly disseminated based on accumulation of hydro-met data to relevant agencies at central and local level as well as outside of pilot river basin.

Objectively Verifiable Indicator b : Evacuation drills are conducted at least one community outside of pilot river basin with EWS.

The recommendations to achieve the Overall Goal are as follows:

Recommendation on the Objectively Verifiable Indicator a:

1. The accumulation of the observation data by using the flood EWS, GTS/MSS and HimawariCast receiving System is an issue in the future, since the operation of those equipment just started in March 2016. It is recommended that NWFWC to raise the accuracy of the flood forecasting and early warning information gradually by reflecting the result of the analysis using the observed long term hydro-met data accumulated in a step-by-step fashion.
2. Raising the accuracy of the weather forecast using the GTS/MSS and HimawariCast receiving system will not be realized soon. Five to 10 years of experience using the equipment will be required. Steady and gradual efforts to raise the accuracy will be essential by continuing the daily weather forecasting using the equipment.
3. As for the other river systems without flood EWS, it is recommended to set tentative alert and alarm water levels based on available information such as flood mark or interview of community people as the basis for the judgement of forecasting and early warning,

Recommendation on the Objectively Verifiable Indicator b:

1. Other than the Pilot river basins, i.e. Mangdechhu and Chamkharchhu basins, it is recommended to install the next Flood Early Warning System (EWS) along the Parochhu and Thimphuchhu river basins that flow through the metropolitan area. It is further recommended to consider this high priority because of the dense population and dense property accumulation on the Paro and Thimphu flood plains.
2. However, as understood through this Project, it is not so easy to install such a full scale flood EWS with flood detecting devices, control room and warning sirens similar to the system installed in the Pilot river basins spending significant budget and time. Even in Japan, it is also noted that not all the major river basins are equipped with such a full scale flood EWS. Therefore, in case of no sufficient DHMS budget, as the first step in the Parochhu and Thimphuchhu river basins, it is recommended to implement the comprehensive measures combining the following structure measures (Simple and practical EWS) and non-structural measures:
    i. Structural measures: Installation of simple and practical flood EWS by combining

    a. Issuing flood alert and alarm utilizing the existing automatic weather station (AWS) and automatic water level stations (AWLS) including those to be installed by UNDP NAPA 2 in near future and,

    b. Dissemination of the flood alert and alarm to NWFWC of DHMS and target vulnerable communities through the existing communication method such as SMS and SNS.

ii. Non-structural measures: the preparation of flood hazard maps, the promotion of Community Based Disaster Risk Management (CBDRM) at vulnerable communities and schools on the flood plain, formulation of the evacuation plan and the implementation of periodic evacuation drills at the communities and schools

Overall recommendation:

1. July 2016 monsoon big flood is the biggest since Cyclone Aila in 2009 and the worst in terms of the damage to infrastructure. Therefore, it is strongly recommended that the relevant agencies such as DDM, DHMS and DoES to jointly review the response of related agencies and community to the flood and the situation of damage and rehabilitation and then to reflect the review result to future strategy, planning and project through the Working Group of the Inter Ministerial Task Force, since July 2016 flood situation includes so many lessons learned.

2. It is rather difficult to realize nationwide disaster resilient society against natural disasters only by the effort of DHMS. As a core of the disaster management administration in Bhutan, it is essential for DDM to establish and start the operation of National Emergency Operation Centre (NEOC) and Dzongkhag Emergency Operation Centre (DEOC) as soon as possible. The disaster resilient society against natural disasters will finally be realized through the coordination and cooperation of NWFWC (DHMS) and NEOC (DDM) like the two wheels of a cart.

Appendix 1

Record of Discussions

RECORD OF DISCUSSIONS

ON

THE PROJECT FOR

CAPACITY DEVELOPMENT OF

GLOF AND RAINSTORM FLOOD FORECASTING AND

EARLY WARNING IN THE KINGDOM OF BHUTAN

AGREED UPON BETWEEN

GROSS NATIONAL HAPPINESS COMMISSION

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, May 14, 2013

Yumiko ASAKUMA
Chief Representative
JICA Bhutan Office

Karma TSHITEEM
Secretary
Gross National Happiness Commission

Based on the minutes of meetings on the Detailed Planning Survey on the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan (hereinafter referred to as "the Project") signed on 18 October, 2012 and on 18 March, 2013 between Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with DHMS and relevant organizations to develop a detailed plan of the Project.

Both parties agreed on the details of the Project and main points discussed as described in Appendix 1 and Appendix 2, respectively, and to request their respective governments to proceed with the necessary procedures for implementation of the Project.

Both parties also agreed that DHMS, the counterpart to JICA, will take the responsibility for the implementation of the Project in cooperation with JICA, coordinate with other relevant organizations and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of Bhutan.

The Project will be implemented within the framework of the Colombo Plan Technical Cooperation Scheme and the Note Verbales to be exchanged between the Government of Japan (hereinafter referred to as "GOJ") and the Royal Government of Bhutan (hereinafter referred to as "RGoB").

The effectiveness of the record of discussions is subject to the exchange of the Note Verbales.

Appendix 1: Project Description
Appendix 2: Minutes of Meetings on 18 October, 2012
Appendix 3: Minutes of Meetings on 18 March, 2013

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there is no change in the Project Description agreed on in the minutes of meetings of October 18, 2012 (Appendix 3) and of March 18, 2013 (Appendix 4) concerning Detailed Planning Survey on the Project.

I. BACKGROUND

Bhutan is experiencing an increase in the number of disasters related to hydro-meteorological hazards, such as flash floods and rainstorm including cyclone that were not observed before. For instance, a record rainfall in May 2009 brought by Cyclone Aila has left 12 people dead and damages to infrastructure, which cost RGoB US$ 15.8 million.

A glacial lake outburst flood (hereinafter referred to as "GLOF") occurs when a body of water that is contained by a glacier or terminal moraine is released. In Bhutan, hazard from GLOF is an urgent environmental and economic issue. Since 1960s, a number of GLOFs have been recorded concurrently with shrink of glaciers and expansion of glacial lakes over the region. The most recent GLOF occurred in October 1994 from the partial burst of the Luggye Tsho in eastern Lunana. This flood caused loss of 21 lives and extensive damage to property along the Punakha- Wangdi valley.

Since the mechanism and event probability of GLOF remains unexplained despite of a number of previous researches, JICA/JST conducted a project "The Study on Glacial Lake Outburst Flood in Bhutan Himalayas" in the period of 2009-2012 to assess GLOF risk in the Mangdechhu River basin, central Bhutan. The project concluded that there is no urgent risk of potential lakes in the basin, which needs to be mitigated by counter measures such as lowering of lake's water level. Considering the catastrophic phenomenon of GLOF, however, the project recommended continuous monitor of glacier lakes as well as development of early warning system in the basin.

With consideration of such situations as mentioned above, RGoB upgraded the Division of Hydro-Met Service to Department and established "National Weather, Flood Forecasting and Warning Center" (hereinafter referred to "NWFFWC") to cope with water related disaster in the country. The hydro-meteorological network in Bhutan has been designed and developed since 1991. However, there is limited or no climate monitoring stations in the northern region where most of the aforementioned disasters have the roots. Moreover, the existing stations are mainly manual operated stations, where data are observed by observers leaving many missing data which are not suitable for climate modeling and related analysis.

In order to meet the natural disasters of hydro-meteorological origins requires adequate multi-tier observation network for in-situ data collection in real or near real time to provide reliable weather forecasting, flood forecasting and warning to safe guard life and property. The current observation network in Bhutan is inadequate in terms of spatial coverage and representativeness.

In response to such background, RGoB sent a request to GOJ for the Project to establish an early warning system for GLOF and rainfall flood in Mangdechhu and Chamkharchhu.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex I) and the tentative Plan of Operation (Annex II).

1. Input
   (1) Input by JICA
   JICA will take, at its own expense, the following measures according to the normal procedures under the Colombo Plan Technical Cooperation:
   (a) Dispatch of Experts
   Details of the dispatch of experts are described in Annex III
   (b) Training
   JICA will receive the Bhutanese personnel connected with the Project for technical training in Japan.
   Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.
   (c) Machinery and Equipment
   JICA will provide such machinery, equipment and other materials (hereinafter referred to as "the Equipment") necessary for the implementation of the Project as listed in Annex IV.
   In case of importation, the Equipment under II-1 (1) (c) above will become the property of the RGoB upon being delivered C.I.F. (cost, insurance and freight) to the Bhutanese authorities concerned at the ports and/or airports of disembarkation.

   Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

   (2) Input by RGoB
   RGoB will take necessary measures to provide at its own expense:
   (a) Services of DHMS's counterpart personnel and administrative personnel as referred to in II-2;
   (b) Suitable office space with necessary equipment;
   (c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
   (d) Information as well as support in obtaining medical service;
   (e) Credentials or identification cards;
   (f) Available data (including maps and photographs) and information related to the Project;
   (g) Running expenses necessary for the implementation of the Project;
   (h) Expenses necessary for transportation within Bhutan of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and
   (i) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Bhutan from Japan in connection

with the implementation of the Project

2. Implementation Structure

The roles and assignments of relevant organizations are as follows:

(1) DHMS
  (a) Project Director
    Director of DHMS
  (b) Project Manager
    Head of Hydrology Division, DHMS

(2) Department of Disaster Management, Ministry of Home and Cultural Affairs (hereinafter referred to as "DDM")

(3) Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as "DGM")

(4) Department of Engineering Services, Ministry of Works and Human Settlements (hereinafter referred to as "DoES")

(5) National Land Commission Secretariat (hereinafter referred to as "NLCS")

(6) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to DHMS on any matters pertaining to the implementation of the Project.

(7) Joint Coordinating Committee

Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve an annual work plan, review overall progress, conduct monitoring and evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex V.

3. Project Site(s) and Beneficiaries

(1) Project Site

Thimphu headquarters

(2) Pilot Site

Mangdechhu, Chamkharchhu river basins

(3) Direct Beneficiaries

DHMS, DDM, DGM, DoES, NLCS, target local government and communities in the Project sites

(4) Indirect Beneficiaries

Bhutanese nationals

4. Duration

The cooperation period of the Project will be three (3) years.

5. Reports

DHMS and JICA experts will jointly prepare the following reports in English.

(1) Inception Report at the beginning of the Project

(2) Progress Report on a semiannual basis until the project completion

(3) Project Completion Report at the time of project completion

6. Environmental and Social Considerations
   (1) RGoB agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF RGoB

1. RGoB will take necessary measures to:
   (1) ensure that the technologies and knowledge acquired by the Bhutan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Bhutan, and that the knowledge and experience acquired by the personnel of Bhutan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and
   (2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts of third countries performing similar missions in Bhutan under the Colombo Plan Technical Cooperation Scheme.

2. RGoB will take necessary measures to:
   (1) provide security-related information as well as measures to ensure the safety of the JICA experts;
   (2) permit the JICA experts to enter, leave and sojourn in Bhutan for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees;
   (3) exempt the JICA experts from taxes and any other charges on the Equipment necessary for the implementation of the Project;
   (4) exempt the JICA experts from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to them and/or remitted to them from abroad for their services in connection with the implementation of the Project; and
   (5) exempt taxes and any other charges on the Equipment, referred to in II-1 above, necessary for the implementation of the Project.

3. RGoB will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. EVALUATION

1. JICA and the RGoB will jointly conduct the following evaluations and reviews:
   (1) Mid-term review at the middle of the cooperation term

(2) Terminal evaluation during the last six (6) months of the cooperation term

2. JICA will conduct the following evaluations and surveys to mainly verify sustainability and impact of the Project and draw lessons. RGoB is required to provide necessary support for them.
   (1) Ex-post evaluation three (3) years after the project completion, in principle
   (2) Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, RGoB will take appropriate measures to make the Project widely known to the people of Bhutan.

VI. MUTUAL CONSULTATION

JICA and RGoB will consult with each other whenever any major issues arise in the course of Project implementation.

VII. AMENDMENTS

The record of discussions may be amended by the minutes of meetings between JICA and RGoB. The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

ANNEX I	PROJECT DESIGN MATRIX (PDM)
ANNEX II	PLAN OF OPERATION
ANNEX III	LIST OF JICA EXPERTS
ANNEX IV	LIST OF EQUIPMENT
ANNEX V	LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
ANNEX VI	LIST OF COUNTERPARTS

ANNEX III

LIST OF JICA EXPERTS
(Tentative)

Fields of experts to be covered by the Japanese experts are as follows:

1. Watershed Disaster Management (Chief Advisor)
2. Meteorology / Climate Change Adaptation
3. Hydrology / Glaciology
4. Flood Hazard Map / GIS
5. Weather Forecasting
6. Information Network / EWS
7. Community Disaster Management

ANNEX IV

LIST OF EQUIPMENT

(Tentative)

1. Equipment related to early warning system
2. Office equipment
3. Other equipment mutually agreed upon as necessary for the implementation of the Project

ANNEX V

LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
(Tentative)

1. Bhutanese side
   - Director of DHMS (Chairperson)
   - Representative of DDM
   - Representative of DGM
   - Representative of DoES
   - Representative of NLCS
   - Representative of GNHC

2. Japanese side
   - Chief Representative of JICA Bhutan Office
   - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

ANNEX VI

LIST OF COUNTERPARTS
(Tentative)

1. DHMS
   Karma Dupchu, Hydrology Division
   Pema Wangdi, Hydrology Division
   Sangay Tenzin, Hydrology Division
   Chhimi Dorji, Planning, Coordination and Research Division
   Tshencho Dorji, Meteorology Division
   Tayaba Tamang, Meteorology Division
   Sangay Tashi, IT officer

2. DDM
3. DGM
4. DoES
   Kelzang Nima, Flood Management Division
5. NLCS

The rest of the members will be confirmed by first JCC

ANNEX I

Tentative Project Design Matrix (PDM)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan

Project Duration: (3 years)

Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan

Target Group: DHMS, DDM, DGM, DoES, NLCS, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated based on accumulation of hydro-met data to relevant agencies at central and local level as well as outside of pilot river basin. b. Evacuation drills are conducted at least one community outside of pilot river basin with EWS.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Plan of institutional strengthening for mainstreaming disaster risk assessment information into development plans is formulated. b. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. c. GLOF/rainstorm flood risk zonation maps are developed. d. Flood and weather forecasting is delivered daily by utilizing improved forecasting system. e. SOP on emergency information sharing is developed.	a. Plan of Institutional strengthening b. Project documents c. The zonation maps d. DHMS weather forecasting and warning report e. SOP at central level	- Staff of DHMS, DGM, DoES , NLCS and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

Activities	Input		
<Output 1> 1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform. 1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system. 1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES. 1-4. Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector. 1-5. Prepare and improve GLOF/rainstorm flood risk zonation to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLCS staff. 1-6. Foster the sense of land use management among related agencies through workshops etc. 1-7. Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans. 1-8. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value). 1-9. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies. <Output 2> 2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood. 2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS. 2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing. 2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools. 2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance. <Output 3> 3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents. 3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-5, 2-2. 3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins. 3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.	【Japanese side】 (1) Dispatch of Experts Experts(7): - Watershed Disaster Management (Chief Advisor) - Meteorology / Climate Change Adaptation - Hydrology / Glaciology - Flood Hazard Map / GIS - Weather Forecasting - Information Network / EWS - Community Disaster Management (2) Provision of Equipment - Detailed contents will be determined through the implementation of the Project. (3) C/P Training in Japan (4) Local cost shared by Japanese side - If necessity arises	【Bhutanese side】 (1) Counterpart(C/P) personnel - Project Director - Project Manager - Counterparts (2) Office space and facilities for the Project - Office space / facilities - Electricity, Water supply and Internet connection (3) Necessary data - Geometric data - Hydro-Meteorological data - Socio-economic data etc. (4) Necessary arrangement - Land allocation for EWS (5) Local cost shared by Bhutanese side	- Necessary budget for the Project is allocated without any significant delay. - Necessary equipment for the Project is procured without significant delay.
			[Pre-condition] Political situation of Bhutan is stable.

ANNEX II

Tentative Plan of Operation (PO0)

	1st Year				2nd Year				3rd Year			
Output 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.												
[1-1] Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.	▨	▨										
[1-2] Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.			▨	▨	▨	▨	▨	▨				
[1-3] Review previous studies including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.	▨	▨	▨	▨								
[1-4] Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector.	▨	▨	▨	▨								
[1-5] Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLC staff.			▨	▨	▨	▨	▨	▨	▨	▨		
[1-6] Foster the sense of land use management among related agencies through workshops etc.				▨	▨				▨	▨	▨	▨
[1-7] Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans.					▨	▨	▨	▨	▨	▨	▨	▨
[1-8] Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).	▨	▨			▨	▨	▨	▨	▨	▨	▨	▨
[1-9] Develop standard operation procedure manuals on emergency information sharing through discussion and workshops with relevant agencies.									▨	▨	▨	▨
Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.												
[2-1] Review existing hydro-meteorological network and planned hydropower plants from the view point of administrative response on GLOF/rainstorm flood.	▨	▨										
[2-2] Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.	▨	▨										
[2-3] Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.	▨	▨										
[2-4] Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.			▨	▨	▨	▨	▨	▨				
[2-5] Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.							▨	▨	▨	▨		
Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.												
[3-1] Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.					▨	▨	▨	▨				
[3-2] List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2.							▨	▨				
[3-3] Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.									▨		▨	
[3-4] Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.											▨	▨

MINUTES OF MEETINGS BETWEEN THE JAPANESE DETAILED PLANNING SURVEY TEAM AND THE AUTHORITIES CONCERNED OF THE GOVERNMENT OF KINGDOM OF BHUTAN ON JAPANESE TECHNICAL COOPERATION FOR THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING IN THE KINGDOM OF BHUTAN

The Japanese Detailed Planning Survey Team (hereinafter referred to as "the Team"), organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Mr. Shiro Nakasone, visited the Kingdom of Bhutan from October 1 to October 19, 2012, for the purpose of formulating the technical cooperation Project on "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" (hereinafter referred to as "the Project").

During its stay, the Team had a series of discussions and exchanged views on the Project with the Bhutanese authorities concerned. As a result of the discussions, the Team and the Bhutanese authorities concerned agreed on the matters referred to in the document attached hereto.

Thimphu, October 18, 2012

Shiro Nakasone
Leader
Japanese Detailed Planning Survey Team
Japan International Cooperation Agency
(JICA)

Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

ATTACHED DOCUMENT

1. Cooperation plan and implementation arrangement for the Project

The Team and the Bhutanese authorities concerned agreed that the cooperation plan, the implementation arrangement and measures to be taken for the Project will be as described in the Draft "Record of Discussions" (hereinafter referred to as "R/D") shown in ATTACHMENT II.

2. Project Purpose

Both sides agreed that the Project focuses on the capacity development for weather and flood forecasting and early warning against Glacial Lake Outburst Flood (hereinafter referred to as "GLOF") and rainstorm flood.

3. Title of the Project

Both sides agreed to change the title of the Project to "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" whose original title was "Development of an Integrated GLOF Early Warning System with Operational Capacity Enhancement for Climate Change Adaptation in Mangdechhu and Chamkharchhu River Basins Project".

4. Target Area

(1) Project site: Thimphu headquarters

(2) Pilot sites: Mangdechhu and Chamkharchhu river basins

5. Cooperation Period of the Project

The cooperation period of the Project will be three (3) years.

6. Procedure before the commencement of the Project

JICA headquarters will undertake the ex-ante evaluation of the Project after the Team returns to Japan and examine the agreed cooperation plan of the Project. In addition, when the Project is considered relevant and viable as a result of the ex-ante evaluation, JICA and the Bhutanese authorities concerned will finalize and sign R/D.

7. Participating organizations of the Project

(1) Implementing Agency
  - Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS")

(2) Co-implementing Agencies
  - Department of Disaster Management, Ministry of Home & Cultural Affairs (hereinafter referred to as "DDM")
  - Department of Geology and Mines, Ministry of Economic Affairs (hereinafter

referred to as "DGM")

- Department of Engineering Services, Ministry of Works and Human Settlement (hereinafter referred to as "DoES")

(3) Japanese Side

JICA will implement the Project with the team of JICA experts.

8. Project Design Matrix

A tentative Project Design Matrix (hereinafter referred to as "PDM") for the Project is shown in ATTACHMENT III.

9. Plan of Operation

A tentative implementation schedule of the Project is shown as the Plan of Operation (hereinafter referred to as "PO") in ATTACHMENT IV.

10. Project Administration

(1) Joint Coordinating Committee (hereinafter referred to as "JCC")

JCC will be organized and meet at least once a year and whenever necessity arises. The following functions will be conducted:

(a) To formulate the annual work plans of the Project;

(b) To review the progress of the annual work plans;

(c) To review and exchange opinions on major issues that may arise during the Project implementation period; and

(d) To discuss any other issues to smoothly implement the Project.

(2) The JCC members

(a) Bhutanese side

- Director of DHMS (Chairperson)
- Representative of DDM
- Representative of DGM
- Representative of DoES
- Representative of GNHC

(b) Japanese side

- Chief Representative of JICA Bhutan Office
- JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

11. JICA's technical cooperation principle

The Team explained the principle of JICA's technical cooperation which pursues capacity development of the counterpart personnel through on-the-job training with JICA experts in the implementation of the Project. Bhutanese side understood the principle of the JICA's technical cooperation.

12. Input from Bhutanese side

Bhutanese side will ensure the following input before the commencement of the Project:

(1) Assignment of counterpart personnel in DHMS, DDM, DGM and DoES;

(2) Office spaces inside the building of DHMS and where JICA experts are expected to be assigned on temporary basis at least during the Project implementation;

(3) Budget allocation for salary for counterpart personnel related to the Project and other expenditure such as transport and travel allowance during the Project;

(4) Budget allocation for running cost of office space (e.g. electricity and water supply, telephone line, internet access etc.) and equipment procured under the Project;

(5) Necessary facility for control station;

(6) Necessary expenses for the data communication of developed information network system; and

(7) Necessary land allocation and permissions for installation of observing and monitoring stations.

13. Others

Both sides agreed the following items:

(1) Installation of equipment

In the Project, some equipment is going to be installed in DHMS and pilot river basins. The installation site and specification of equipment will be defined during the early stage of the Project. Also, necessary staff will be assigned for the operation of the equipment after installation.

(2) Target districts related to Output 3 of the Project

Target districts related to Output 3 of the Project are Trongsa and Bumthang Dzongkhags. If flood risk community is recognized in the implementation process of the Project, however, Zhemgang Dzongkhag might be included as a target district.

(3) Coordination with other development partners

DHMS will ensure the coordination between the Project and assistance by other development partners such as United Nations Development Programme (UNDP) for pursuing synergy effect with each other.

(4) Staff allocation to National Weather, Flood Forecasting and Warning Center

(hereinafter referred to as NWFFWC)

DHMS staff trained in the Project will be assigned as core member of NWFFWC after full operation of NWFFWC in order to ensure the persistent activity of the Project.

(5) Project working group

For the smooth implementation of the Project, DHMS will organize working groups in collaboration with co-implementing agencies and JICA experts tentatively listed as follows;

- Information network;
- Risk assessment;
- Flood and weather forecasting; and
- Early warning and community awareness.

ATTACHMENT I	ATTENDANT LIST
ATTACHMENT II	DRAFT RECORD OF DISCUSSIONS
ATTACHMENT III	PROJECT DESIGN MATRIX (PDM)
ATTACHMENT IV	PLAN OF OPERATION (PO)

ATTACHMENT I

ATTENDANT LIST

Bhutanese side:

Gross National Happiness Commission (GNHC)

- Kuenzang Lham Sangey

Ministry of Economic Affairs

- Sonam Yangley
- Karma Tsering
- Karma Dupchu
- K.Radhakrishnan
- Chimi Dorji
- Tshencho Dorji
- Pema Wangdi

Department of Disaster Management, Ministry of Home and Cultural Affairs (DDM)

- Pelden Zangmo

Japanese side:

Detailed Planning Survey Team, JICA

- Shiro Nakasone, Leader
- Toru Koike, Glacial Lake Outburst Flood
- Yasunori Minagawa, Evaluation Analysis
- Kazuki Kaiya, Planning and Disaster Management Cooperation

JICA Bhutan Office

- Nitta Tomoki, Chief Representative
- Miharu Furukawa, Project Formulation Advisor

ATTACHMENT II

(DRAFT)
RECORD OF DISCUSSIONS

ON

THE PROJECT FOR

CAPACITY DEVELOPMENT OF

GLOF AND RAINSTORM FLOOD FORECASTING AND

EARLY WARNING IN THE KINGDOM OF BHUTAN

AGREED UPON BETWEEN

GROSS NATIONAL HAPPINESS COMMISSION

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, XX XX 2012

Chief Representative of JICA Bhutan	Secretary of Gross National Happiness Commission

Based on the minutes of meetings on the Detailed Planning Survey on the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan (hereinafter referred to as "the Project") signed on 18 October 2012 between Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with DHMS and relevant organizations to develop a detailed plan of the Project.

Both parties agreed the details of the Project and main points discussed as described in the Appendix 1 and the Appendix 2, respectively, and to request their respective governments to proceed with the necessary procedures for implementation of the Project.

Both parties also agreed that DHMS, the counterpart to JICA, will be responsible for the implementation of the Project in cooperation with JICA, coordinate with other relevant organizations and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of Bhutan.

The Project will be implemented within the framework of the Colombo Plan Technical Cooperation Scheme and the Note Verbales to be exchanged between the Government of Japan (hereinafter referred to as "GOJ") and the Royal Government of Bhutan (hereinafter referred to as "RGoB").

The effectiveness of the record of discussions is subject to the exchange of the Note Verbales.

Appendix 1: Project Description
Appendix 2: Main Points Discussed * To be attached if necessary
Appendix 3: Minutes of Meetings on 18 October 2012

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there is no change in the Project Description agreed on in the minutes of meetings on the concerning Detailed Planning Survey on the Project signed on 18 October 2012 (Appendix 3).

I. BACKGROUND

Bhutan is experiencing the increase in number of disasters related to hydro-meteorological hazards such as flash floods and rainstorm including cyclone (Aila in May 2009) that were not observed before. For instance a record rainfall brought by cyclone Aila has left 12 people dead and damage to infrastructure, and cost the government US$ 15.800 million.

A glacial lake outburst flood (hereinafter referred to as "GLOF") occurs when a body of water that is contained by a glacier or terminal moraine is released. In Bhutan, hazard from GLOF is an urgent environmental and economic issue. Since 1960s, a number of GLOFs have been recorded concurrently with shrink of glaciers and expansion of glacial lakes over the region. The most recent GLOF occurred in October 1994 from the partial burst of the Luggye Tsho in eastern Lunana. This flood caused loss of 21 lives and extensive damage to property along the Punakha- Wangdi valley.

Since the mechanism and event probability of GLOF remains unexplained despite of a number of previous researches, JICA/JST conducted a project "The Study on Glacial Lake Outburst Flood in Bhutan Himalayas" in the period of 2009-2012 to assess GLOF risk in the Mangdechhu River basin, central Bhutan. The project concluded that there is no urgent risk of potential lakes in the basin, which needs to be mitigated by counter measures such as lowering of lake's water level. Considering the catastrophic phenomenon of GLOF, however, the project recommended continuous monitor of glacier lakes as well as development of early warning system in the basin.

With consideration of such situations as mentioned above, Bhutanese government upgraded the Division of Hydro-Met Service to Department and established "National Weather, Flood Forecasting and Warning Center" (hereinafter referred to "NWFFWC") to cope with water related disaster in the country. The hydro-meteorological network in Bhutan has been designed and developed since 1991. However, there is limited or no climate monitoring stations in the northern region where most of the aforementioned disasters have the roots. Moreover, the existing stations are mainly manual operated stations, where data are observed by observers leaving many missing data which are not suitable for climate modeling and related analysis.

In order to meet the natural disasters of hydro-meteorological origins requires adequate multi-tier observation network for in-situ data collection in real or near real time to provide reliable weather forecasting, flood forecasting and warning to safe guard life and property. The current observation network in Bhutan is inadequate in terms of spatial coverage and representativeness.

In response to such background, Bhutanese government requested to Japanese government the Project for establishing early warning system for GLOF and rainfall flood in Mangdechhu and Chamkharchhu.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex XX) and the tentative Plan of Operation (Annex XX).

1. Input

(1) Input by JICA

JICA will take, at its own expense, the following measures according to the normal procedures under the Colombo Plan Technical Cooperation:

(a) Dispatch of Experts

Details of the dispatch of experts are described in Annex III

(b) Training

JICA will receive the Bhutanese personnel connected with the Project for technical training in Japan.

Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

(c) Machinery and Equipment

JICA will provide such machinery, equipment and other materials (hereinafter referred to as "the Equipment") necessary for the implementation of the Project as listed in Annex IV.

In case of importation, the machinery, equipment and other materials under II-1 (1) (c) above will become the property of the RGoB upon being delivered C.I.F. (cost, insurance and freight) to the Bhutan authorities concerned at the ports and/or airports of disembarkation.

Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

(2) Input by RGoB

RGoB will take necessary measures to provide at its own expense:

(a) Services of DHMS's counterpart personnel and administrative personnel as referred to in II-2;

(b) Suitable office space with necessary equipment;

(c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;

(d) Information as well as support in obtaining medical service;

(e) Credentials or identification cards;

(f) Available data (including maps and photographs) and information related to the Project;

(g) Running expenses necessary for the implementation of the Project;

(h) Expenses necessary for transportation within Bhutan of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and

(i) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Bhutan from Japan in connection with the implementation of the Project

2. Implementation Structure

The roles and assignments of relevant organizations are as follows:

(1) DHMS
  (a) Project Director
    Director of DHMS
  (b) Project Manager
    Head of Hydrology Division, DHMS

(2) Department of Disaster Management, Ministry of Home and Cultural Affairs (hereinafter referred to as DDM)

(3) Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as DGM)

(4) Department of Engineering Services, Ministry of Works and Human Settlements (hereinafter referred to as DoES)

(5) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to DHMS on any matters pertaining to the implementation of the Project.

(6) Joint Coordinating Committee

Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve an annual work plan, review overall progress, conduct monitoring and evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex XX.

3. Project Site(s) and Beneficiaries

(1)Project Site
  Thimphu headquarters

(2)Pilot Site
  Mangdechhu, Chamkharchhu river basins

(3)Direct Beneficiary
  DHMS, DDM, DGM, DoES, Target local government and community in the Project sites

(4)Indirect Beneficiary
  Bhutanese people

4. Duration

The cooperation period of the Project will be three (3) years.

5. Reports

DHMS and JICA experts will jointly prepare the following reports in English.

(1) Inception Report at the beginning of the Project

(2) Progress Report on semiannual basis until the project completion

(3) Project Completion Report at the time of project completion

6. Environmental and Social Considerations
   (1) RGoB agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF RGoB

1. RGoB will take necessary measures to:
   (1) ensure that the technologies and knowledge acquired by the Bhutan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Bhutan, and that the knowledge and experience acquired by the personnel of Bhutan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and
   (2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts of third countries performing similar missions in Bhutan under the Colombo Plan Technical Cooperation Scheme.

2. RGoB will take necessary measures to:
   (1) provide security-related information as well as measures to ensure the safety of the JICA experts;
   (2) permit the JICA experts to enter, leave and sojourn in Bhutan for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees.
   (3) exempt the JICA experts from taxes and any other charges on the equipment, machinery and other material necessary for the implementation of the Project;
   (4) exempt the JICA experts from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to them and/or remitted to them from abroad for their services in connection with the implementation of the Project; and
   (5) exempt taxes and any other charges on the equipment, machinery and other material, referred to in II-1 above, necessary for the implementation of the Project.

3. RGoB will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. EVALUATION

1. JICA and the RGoB will jointly conduct the following evaluations and reviews.

(1) Mid-term review at the middle of the cooperation term
(2) Terminal evaluation during the last six (6) months of the cooperation term

2. JICA will conduct the following evaluations and surveys to mainly verify sustainability and impact of the Project and draw lessons. The RGoB is required to provide necessary support for them.
   (1) Ex-post evaluation three (3) years after the project completion, in principle
   (2) Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, RGoB will take appropriate measures to make the Project widely known to the people of Bhutan.

VI. MUTUAL CONSULTATION

JICA and RGoB will consult with each other whenever any major issues arise in the course of Project implementation.

VII. AMENDMENTS

The record of discussions may be amended by the minutes of meetings between JICA and RGoB.
The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

ANNEX I	PROJECT DESIGN MATRIX (PDM)
ANNEX II	PLAN OF OPERATION
ANNEX III	LIST OF JICA EXPERTS
ANNEX IV	LIST OF EQUIPMENT
ANNEX V	LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
ANNEX VI	LIST OF COUNTERPARTS

ANNEX III

LIST OF JICA EXPERTS
(Tentative)

Fields of experts to be covered by the Japanese experts are as follows:

1. Watershed Disaster Management (Chief Advisor)
2. Meteorology / Climate Change Adaptation
3. Hydrology / Glaciology
4. Flood Hazard Map / GIS
5. Weather Forecasting
6. Information Network / EWS
7. Community Disaster Management

ANNEX IV

LIST OF EQUIPMENT
(Tentative)

1. Equipment related to early warning system
2. Office equipment
3. Other equipment mutually agreed upon as necessary for the implementation of the Project

ANNEX V

LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
(Tentative)

1. Bhutanese side
    - Director of DHMS (Chairperson)
    - Representative of DDM
    - Representative of DGM
    - Representative of DoES
    - Representative of GNHC

2. Japanese side
    - Chief Representative of JICA Bhutan Office
    - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

ANNEX VI

LIST OF COUNTERPARTS
(Tentative)

1. DHMS
   Karma Dupchu, Hydrology Division
   Pema Wangdi, Hydrology Division
   Sangay Tenzin, Hydrology Division
   Chhimi Dorji, Planning, Coordination and Research Division
   Tshencho Dorji, Meteorology Division
   Tayaba Tamang, Meteorology Division
   Sangay Tashi, IT officer

2. DDM
3. DGM
4. DoES
   Kelzang Nima, Flood Management Division

The rest of member will be confirmed by signing of R/D

Appendix 2

MAIN POINTS DISCUSSED

(Tentative)

ATTACHMENT III

Tentative Project Design Matrix (PDM0)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan

Project Duration: (3 years)

Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan

Target Group : DHMS, DDM, DGM, DoES, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated to relevant agencies at central and local level.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. b. GLOF/rainstorm flood risk zonation maps are developed. c. Flood and weather forecasting is daily delivered utilizing improved forecasting system. d. SOP on emergency information sharing is developed.	a. Project documents b. The zonation maps c. SOP at central level	- Staff of DHMS, DGM, DoES and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

Activities	Input		
<Output 1> 1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform. 1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system. 1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES. 1-4. Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM and DoES staff. 1-5. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value). 1-6. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies. <Output 2> 2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood. 2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS. 2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing. 2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools. 2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance. <Output 3> 3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents. 3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2. 3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins. 3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.	【Japanese side】 (1) Dispatch of Experts Experts(7): - Watershed Disaster Management (Chief Advisor) - Meteorology / Climate Change Adaptation - Hydrology / Glaciology - Flood Hazard Map / GIS - Weather Forecasting - Information Network / EWS - Community Disaster Management (2) Provision of equipment - Detailed contents will be determined through the implementation of the Project. (3) C/P Training in Japan (4) Local cost shared by Japanese side - If necessity arises	【Bhutan side】 (1) Counterpart(C/P) personnel - Project Director - Project Manager - Counterparts (2) Office space and facilities for the Project - Office space / facilities - Electricity, Water supply and Internet connection (3) Necessary data - Geometric data - Hydro-Meteorological data - Socio-economic data etc. (4) Necessary arrangement - Land allocation for EWS (5) Local cost shared by Bhutan side	- Necessary budget for the Project is allocated without any significant delay. - Necessary equipment for the Project is procured without significant delay.
			[Pre-condition] Political situation of Bhutan is stable.

Tentative Plan of Operation (PO0)

ATTACHMENT IV

	1st Year				2nd Year				3rd Year			
Output 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.												
[1-1] Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.	■	■										
[1-2] Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.			■	■	■	■	■	■				
[1-3] Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.	■	■	■	■								
[1-4] Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM and DoES Staff.			■	■	■	■	■	■	■	■		
[1-5] Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).	■	■			■	■	■	■	■	■	■	■
[1-6] Develop standard operation procedure manuals on emergency information sharing through discussion and workshops with relevant agencies.									■	■	■	■
Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.												
[2-1] Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood.	■	■										
[2-2] Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.	■	■										
[2-3] Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.	■	■										
[2-4] Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.			■	■	■	■						
[2-5] Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.							■	■		■		
Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.												
[3-1] Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.					■	■	■	■				
[3-2] List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2.							■	■				
[3-3] Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.									■		■	
[3-4] Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.											■	■

MINUTES OF MEETINGS
BETWEEN
THE JAPANESE DETAILED PLANNING SURVEY TEAM
AND
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
ON
JAPANESE TECHNICAL COOPERATION
FOR
THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING IN THE KINGDOM OF BHUTAN

The Japanese Detailed Planning Survey Team (hereinafter referred to as "the Team"), organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Dr. Hitoshi Baba, visited the Kingdom of Bhutan from March 11 to 19, 2013, for the purpose of formulating the technical cooperation Project on "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" (hereinafter referred to as "the Project").

During its stay, the Team had a series of discussions and exchanged views on the Project with the Bhutanese authorities concerned. As a result of the discussions, the Team and the Bhutanese authorities concerned agreed to revise the document signed on October 18, 2012 referred under ATTACHMENT V (The revised parts are indicated as underlined).

Thimphu, March 18, 2013

Hitoshi Baba
Leader
Japanese Detailed Planning Survey Team
Japan International Cooperation Agency
(JICA)

Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

ATTACHED DOCUMENT

1. Cooperation plan and implementation arrangement for the Project

The Team and the Bhutanese authorities concerned agreed that the cooperation plan, the implementation arrangement and measures to be taken for the Project will be as described in the Draft "Record of Discussions" (hereinafter referred to as "R/D") shown in ATTACHMENT II.

2. Project Purpose

Both sides agreed that the Project focuses on the capacity development for weather and flood forecasting and early warning against Glacial Lake Outburst Flood (hereinafter referred to as "GLOF") and rainstorm flood. In addition to those, both sides agreed that the Project also contribute for mainstreaming disaster risk assessment information into development plans.

3. Title of the Project

Both sides agreed to change the title of the Project to "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" whose original title was "Development of an Integrated GLOF Early Warning System with Operational Capacity Enhancement for Climate Change Adaptation in Mangdechhu and Chamkharchhu River Basins Project".

4. Target Area

(1) Project site: Thimphu headquarters

(2) Pilot sites: Mangdechhu and Chamkharchhu river basins

5. Cooperation Period of the Project

The cooperation period of the Project will be three (3) years.

6. Procedure before the commencement of the Project

JICA headquarters will undertake the ex-ante evaluation of the Project after the Team returns to Japan and examine the agreed cooperation plan of the Project. In addition, when the Project is considered relevant and viable as a result of the ex-ante evaluation, JICA and the Bhutanese authorities concerned will finalize and sign R/D.

7. Participating organizations of the Project

(1) Implementing Agency

- Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS")

(2) Co-implementing Agencies

- Department of Disaster Management, Ministry of Home & Cultural Affairs

(hereinafter referred to as "DDM")

- Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as "DGM")
- Department of Engineering Services, Ministry of Works and Human Settlement (hereinafter referred to as "DoES")
- National Land Commission Secretariat (hereinafter referred to as "NLCS")

(3) Japanese Side

JICA will implement the Project with the team of JICA experts.

8. Project Design Matrix

A tentative Project Design Matrix (hereinafter referred to as "PDM") for the Project is shown in ATTACHMENT III.

9. Plan of Operation

A tentative implementation schedule of the Project is shown as the Plan of Operation (hereinafter referred to as "PO") in ATTACHMENT IV.

10. Project Administration

(1) Joint Coordinating Committee (hereinafter referred to as "JCC")

JCC will be organized and meet at least once a year and whenever necessity arises. The following functions will be conducted:

(a) To formulate the annual work plans of the Project;

(b) To review the progress of the annual work plans;

(c) To review and exchange opinions on major issues that may arise during the Project implementation period; and

(d) To discuss any other issues to smoothly implement the Project.

(2) The JCC members

(a) Bhutanese side

- Director of DHMS (Chairperson)
- Representative of DDM
- Representative of DGM
- Representative of DoES
- Representative of GNHC
- Representative of NLCS

(b) Japanese side

- Chief Representative of JICA Bhutan Office
- JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

11. JICA's technical cooperation principle

The Team explained the principle of JICA's technical cooperation which pursues capacity development of the counterpart personnel through on-the-job training with JICA experts in the implementation of the Project. Bhutanese side understood the principle of the JICA's technical cooperation.

12. Input from Bhutanese side

Bhutanese side will ensure the following input before the commencement of the Project:

(1) Assignment of counterpart personnel in DHMS, DDM, DGM, DoES and <u>NLCS</u>;

(2) Office spaces inside the building of DHMS and where JICA experts are expected to be assigned on temporary basis at least during the Project implementation;

(3) Budget allocation for salary for counterpart personnel related to the Project and other expenditure such as transport and travel allowance during the Project;

(4) Budget allocation for running cost of office space (e.g. electricity and water supply, telephone line, internet access etc.) and equipment procured under the Project;

(5) Necessary facility for control station;

(6) Necessary expenses for the data communication of developed information network system; and

(7) Necessary land allocation and permissions for installation of observing and monitoring stations.

13. Others

Both sides agreed the following items:

(1) Installation of equipment

In the Project, some equipment is going to be installed in DHMS and pilot river basins, <u>the concept of network system of which is shown in ATTACHMENT VI.</u> The installation site and specification of equipment will be defined during the early stage of the Project. Also, necessary staff will be assigned for the operation of the equipment after installation <u>as shown in ATTACHMENT VII.</u>

(2) Target districts related to Output 3 of the Project

Target districts related to Output 3 of the Project are Trongsa and Bumthang Dzongkhags. If flood risk community is recognized in the implementation process of the Project, however, Zhemgang Dzongkhag might be included as a target district.

(3) Coordination with other development partners

DHMS will ensure the coordination between the Project and assistance by other development partners such as United Nations Development Programme (UNDP) for pursuing synergy effect with each other.

(4) Staff allocation to National Weather, Flood Forecasting and Warning Center (hereinafter referred to as NWFFWC)

DHMS staff trained in the Project will be assigned as core member of NWFFWC after full operation of NWFFWC in order to ensure the persistent activity of the Project.

(5) Project working group

For the smooth implementation of the Project, DHMS will organize working groups in collaboration with co-implementing agencies and JICA experts tentatively listed as follows;

- Information network;
- Risk assessment;
- Flood and weather forecasting; and
- Early warning and community awareness.

(6) The Project activities related to the Disaster Management Act

Since the Disaster Management Act has just enacted, the Bhutanese authorities concerned may need to further establish relevant fundamentals such as regulations and institutional setups. The Project will support the authorities in accordance to the progress of the establishment through the activities 1-4 and 1-7 described in the PDM, with the purpose of raising the level of intervention in disaster risk reduction particularly.

ATTACHMENT I	ATTENDANT LIST
ATTACHMENT II	DRAFT RECORD OF DISCUSSIONS
ATTACHMENT III	PROJECT DESIGN MATRIX (PDM)
ATTACHMENT IV	PLAN OF OPERATION (PO)
ATTACHMENT V	M/M SIGNED ON OCTOBER 18, 2012
ATTACHMENT VI	CONCEPT OF NETWORK SYSTEM
ATTACHMENT VII	PERSONNEL PLAN OF DHMS

ATTACHMENT I

ATTENDANT LIST

Bhutanese side:

Ministry of Economic Affairs

- Karma Tsering
- Karma Dupchu
- Singey Dorji
- Pema Wangdi

Japanese side:

Detailed Planning Survey Team, JICA

- Hitoshi Baba, Leader
- Kunio Akatsu, Hydro-Meteorological Network
- Kazuki Kaiya, Planning and Disaster Management Cooperation

JICA Bhutan Office

- Miharu Furukawa, Project Formulation Advisor

ATTACHMENT II

(DRAFT) RECORD OF DISCUSSIONS

ON

THE PROJECT FOR

CAPACITY DEVELOPMENT OF

GLOF AND RAINSTORM FLOOD FORECASTING AND

EARLY WARNING IN THE KINGDOM OF BHUTAN

AGREED UPON BETWEEN

GROSS NATIONAL HAPPINESS COMMISSION

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, XX XX 2013

Chief Representative of JICA Bhutan	Secretary of Gross National Happiness Commission

Based on the minutes of meetings on the Detailed Planning Survey on the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan (hereinafter referred to as "the Project") signed on 18 October, 2012 and on 18 March, 2013 between Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with DHMS and relevant organizations to develop a detailed plan of the Project.

Both parties agreed the details of the Project and main points discussed as described in the Appendix 1 and the Appendix 2, respectively, and to request their respective governments to proceed with the necessary procedures for implementation of the Project.

Both parties also agreed that DHMS, the counterpart to JICA, will be responsible for the implementation of the Project in cooperation with JICA, coordinate with other relevant organizations and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of Bhutan.

The Project will be implemented within the framework of the Colombo Plan Technical Cooperation Scheme and the Note Verbales to be exchanged between the Government of Japan (hereinafter referred to as "GOJ") and the Royal Government of Bhutan (hereinafter referred to as "RGoB").

The effectiveness of the record of discussions is subject to the exchange of the Note Verbales.

Appendix 1: Project Description
Appendix 2: Main Points Discussed * To be attached if necessary
Appendix 3: Minutes of Meetings on 18 October, 2012
Appendix 4: Minutes of Meetings on 18 March, 2013

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there is no change in the Project Description agreed on in the minutes of meetings of October 18, 2012 (Appendix3) and of March 18, 2013 (Appendix 4) concerning Detailed Planning Survey on the Project.

I. BACKGROUND

Bhutan is experiencing the increase in number of disasters related to hydro-meteorological hazards such as flash floods and rainstorm including cyclone (Aila in May 2009) that were not observed before. For instance a record rainfall brought by cyclone Aila has left 12 people dead and damage to infrastructure, and cost the government US$ 15.800 million.

A glacial lake outburst flood (hereinafter referred to as "GLOF") occurs when a body of water that is contained by a glacier or terminal moraine is released. In Bhutan, hazard from GLOF is an urgent environmental and economic issue. Since 1960s, a number of GLOFs have been recorded concurrently with shrink of glaciers and expansion of glacial lakes over the region. The most recent GLOF occurred in October 1994 from the partial burst of the Luggye Tsho in eastern Lunana. This flood caused loss of 21 lives and extensive damage to property along the Punakha- Wangdi valley.

Since the mechanism and event probability of GLOF remains unexplained despite of a number of previous researches, JICA/JST conducted a project "The Study on Glacial Lake Outburst Flood in Bhutan Himalayas" in the period of 2009-2012 to assess GLOF risk in the Mangdechhu River basin, central Bhutan. The project concluded that there is no urgent risk of potential lakes in the basin, which needs to be mitigated by counter measures such as lowering of lake's water level. Considering the catastrophic phenomenon of GLOF, however, the project recommended continuous monitor of glacier lakes as well as development of early warning system in the basin.

With consideration of such situations as mentioned above, Bhutanese government upgraded the Division of Hydro-Met Service to Department and established "National Weather, Flood Forecasting and Warning Center" (hereinafter referred to "NWFFWC") to cope with water related disaster in the country. The hydro-meteorological network in Bhutan has been designed and developed since 1991. However, there is limited or no climate monitoring stations in the northern region where most of the aforementioned disasters have the roots. Moreover, the existing stations are mainly manual operated stations, where data are observed by observers leaving many missing data which are not suitable for climate modeling and related analysis.

In order to meet the natural disasters of hydro-meteorological origins requires adequate multi-tier observation network for in-situ data collection in real or near real time to provide reliable weather forecasting, flood forecasting and warning to safe guard life and property. The current observation network in Bhutan is inadequate in terms of spatial coverage and representativeness.

In response to such background, Bhutanese government requested to Japanese government the Project for establishing early warning system for GLOF and rainfall flood in Mangdechhu and Chamkharchhu.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex XX) and the tentative Plan of Operation (Annex XX).

1. Input
   (1) Input by JICA
   JICA will take, at its own expense, the following measures according to the normal procedures under the Colombo Plan Technical Cooperation:
   (a) Dispatch of Experts
   Details of the dispatch of experts are described in Annex III
   (b) Training
   JICA will receive the Bhutanese personnel connected with the Project for technical training in Japan.
   Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.
   (c) Machinery and Equipment
   JICA will provide such machinery, equipment and other materials (hereinafter referred to as "the Equipment") necessary for the implementation of the Project as listed in Annex IV.
   In case of importation, the Equipment under II-1 (1) (c) above will become the property of the RGoB upon being delivered C.I.F. (cost, insurance and freight) to the Bhutan authorities concerned at the ports and/or airports of disembarkation.

   Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

   (2) Input by RGoB
   RGoB will take necessary measures to provide at its own expense:
   (a) Services of DHMS's counterpart personnel and administrative personnel as referred to in II-2;
   (b) Suitable office space with necessary equipment;
   (c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
   (d) Information as well as support in obtaining medical service;
   (e) Credentials or identification cards;
   (f) Available data (including maps and photographs) and information related to the Project;
   (g) Running expenses necessary for the implementation of the Project;
   (h) Expenses necessary for transportation within Bhutan of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and
   (i) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Bhutan from Japan in connection

with the implementation of the Project

2. Implementation Structure

The roles and assignments of relevant organizations are as follows:

(1) DHMS

(a) Project Director

Director of DHMS

(b) Project Manager

Head of Hydrology Division, DHMS

(2) Department of Disaster Management, Ministry of Home and Cultural Affairs (hereinafter referred to as DDM)

(3) Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as DGM)

(4) Department of Engineering Services, Ministry of Works and Human Settlements (hereinafter referred to as DoES)

(5) National Land Commission Secretariat (hereinafter referred to as NLCS)

(6) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to DHMS on any matters pertaining to the implementation of the Project.

(7) Joint Coordinating Committee

Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve an annual work plan, review overall progress, conduct monitoring and evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex XX.

3. Project Site(s) and Beneficiaries

(1)Project Site

Thimphu headquarters

(2)Pilot Site

Mangdechhu, Chamkharchhu river basins

(3)Direct Beneficiary

DHMS, DDM, DGM, DoES, NLCS, Target local government and community in the Project sites

(4)Indirect Beneficiary

Bhutanese people

4. Duration

The cooperation period of the Project will be three (3) years.

5. Reports

DHMS and JICA experts will jointly prepare the following reports in English.

(1) Inception Report at the beginning of the Project

(2) Progress Report on semiannual basis until the project completion

(3) Project Completion Report at the time of project completion

6. Environmental and Social Considerations

(1) RGoB agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF RGoB

1. RGoB will take necessary measures to:

(1) ensure that the technologies and knowledge acquired by the Bhutan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Bhutan, and that the knowledge and experience acquired by the personnel of Bhutan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts of third countries performing similar missions in Bhutan under the Colombo Plan Technical Cooperation Scheme.

2. RGoB will take necessary measures to:

(1) provide security-related information as well as measures to ensure the safety of the JICA experts;

(2) permit the JICA experts to enter, leave and sojourn in Bhutan for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees.

(3) exempt the JICA experts from taxes and any other charges on the Equipment necessary for the implementation of the Project;

(4) exempt the JICA experts from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to them and/or remitted to them from abroad for their services in connection with the implementation of the Project; and

(5) exempt taxes and any other charges on the Equipment, referred to in II-1 above, necessary for the implementation of the Project.

3. RGoB will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. EVALUATION

1. JICA and the RGoB will jointly conduct the following evaluations and reviews.

(1) Mid-term review at the middle of the cooperation term

(2) Terminal evaluation during the last six (6) months of the cooperation term

2. JICA will conduct the following evaluations and surveys to mainly verify sustainability and impact of the Project and draw lessons. The RGoB is required to provide necessary support for them.
   (1) Ex-post evaluation three (3) years after the project completion, in principle
   (2) Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, RGoB will take appropriate measures to make the Project widely known to the people of Bhutan.

VI. MUTUAL CONSULTATION

JICA and RGoB will consult with each other whenever any major issues arise in the course of Project implementation.

VII. AMENDMENTS

The record of discussions may be amended by the minutes of meetings between JICA and RGoB.
The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

ANNEX I	PROJECT DESIGN MATRIX (PDM)
ANNEX II	PLAN OF OPERATION
ANNEX III	LIST OF JICA EXPERTS
ANNEX IV	LIST OF EQUIPMENT
ANNEX V	LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
ANNEX VI	LIST OF COUNTERPARTS

ANNEX III

LIST OF JICA EXPERTS
(Tentative)

Fields of experts to be covered by the Japanese experts are as follows:

1. Watershed Disaster Management (Chief Advisor)
2. Meteorology / Climate Change Adaptation
3. Hydrology / Glaciology
4. Flood Hazard Map / GIS
5. Weather Forecasting
6. Information Network / EWS
7. Community Disaster Management

ANNEX IV

LIST OF EQUIPMENT
(Tentative)

1. Equipment related to early warning system
2. Office equipment
3. Other equipment mutually agreed upon as necessary for the implementation of the Project

ANNEX V

LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
(Tentative)

1. Bhutanese side
    - Director of DHMS (Chairperson)
    - Representative of DDM
    - Representative of DGM
    - Representative of DoES
    - Representative of NLCS
    - Representative of GNHC

2. Japanese side
    - Chief Representative of JICA Bhutan Office
    - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

ANNEX VI

LIST OF COUNTERPARTS
(Tentative)

1. DHMS
   Karma Dupchu, Hydrology Division
   Pema Wangdi, Hydrology Division
   Sangay Tenzin, Hydrology Division
   Chhimi Dorji, Planning, Coordination and Research Division
   Tshencho Dorji, Meteorology Division
   Tayaba Tamang, Meteorology Division
   Sangay Tashi, IT officer

2. DDM
3. DGM
4. DoES
   Kelzang Nima, Flood Management Division
5. <u>NLCS</u>

The rest of member will be confirmed by signing of R/D

Appendix 2

MAIN POINTS DISCUSSED

(Tentative)

ATTACHMENT III

Tentative Project Design Matrix (PDM)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan
Project Duration: (3 years)
Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan
Target Group : DHMS, DDM, DGM, DoES, NLCS, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated to relevant agencies at central and local level.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Plan of institutional strengthening for mainstreaming disaster risk assessment information into development plans is formulated. b. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. c. GLOF/rainstorm flood risk zonation maps are developed. d. Flood and weather forecasting is daily delivered utilizing improved forecasting system. e. SOP on emergency information sharing is developed.	a. Plan of Institutional strengthening b. Project documents c. The zonation maps d. DHMS weather forecasting and warning report e. SOP at central level	- Staff of DHMS, DGM, DoES and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

Activities	Input		
<Output 1> 1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform. 1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system. 1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES. 1-4. Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector. 1-5. Prepare and improve GLOF/rainstorm flood risk zonation to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLCS staff. 1-6. Foster the sense of land use management among related agencies through workshops etc. 1-7. Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans. 1-8. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value). 1-9. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies. <Output 2> 2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood. 2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS. 2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing. 2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools. 2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance. <Output 3> 3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents. 3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2. 3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins. 3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.	【Japanese side】 (1) Dispatch of Experts Experts(7): - Watershed Disaster Management (Chief Advisor) - Meteorology / Climate Change Adaptation - Hydrology / Glaciology - Flood Hazard Map / GIS - Weather Forecasting - Information Network / EWS - Community Disaster Management (2) Provision of equipment - Detailed contents will be determined through the implementation of the Project. (3) C/P Training in Japan (4) Local cost shared by Japanese side - If necessity arises	【Bhutan side】 (1) Counterpart(C/P) personnel - Project Director - Project Manager - Counterparts (2) Office space and facilities for the Project - Office space / facilities - Electricity, Water supply and Internet connection (3) Necessary data - Geometric data - Hydro-Meteorological data - Socio-economic data etc. (4) Necessary arrangement - Land allocation for EWS (5) Local cost shared by Bhutan side	- Necessary budget for the Project is allocated without any significant delay. - Necessary equipment for the Project is procured without significant delay. [Pre-condition] Political situation of Bhutan is stable.

Tentative Plan of Operation (PO0)

ATTACHMENT IV

	1st Year												2nd Year												3rd Year											
Output 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.																																				
[1-1] Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.	■	■	■	■	■	■																														
[1-2] Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
[1-3] Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.			■	■	■	■	■	■	■	■	■	■																								
[1-4] Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector.	■	■	■	■	■	■	■	■	■	■	■	■																								
[1-5] Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLC staff.							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
[1-6] Foster the sense of land use management among related agencies through workshops etc.											■	■	■	■	■										■	■	■	■	■	■	■	■	■	■	■	■
[1-7] Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans.													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
[1-8] Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
[1-9] Develop standard operation procedure manuals on emergency information sharing through discussion and workshops with relevant agencies.																									■	■	■	■	■	■	■	■	■	■	■	■
Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.																																				
[2-1] Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood.	■	■	■	■	■	■																														
[2-2] Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.			■	■	■	■																														
[2-3] Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.	■	■	■	■	■	■																														
[2-4] Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
[2-5] Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.																			■	■	■	■	■	■	■	■	■	■	■	■						
Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.																																				
[3-1] Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.													■	■	■	■	■	■	■	■	■	■	■	■												
[3-2] List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2.																			■	■	■	■	■	■												
[3-3] Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.																									■	■	■				■	■	■			
[3-4] Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.																															■	■	■	■	■	■

MINUTES OF MEETINGS
BETWEEN
THE JAPANESE DETAILED PLANNING SURVEY TEAM
AND
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
ON
JAPANESE TECHNICAL COOPERATION
FOR
THE PROJECT FOR CAPACITY DEVELOPMENT OF
GLOF AND RAINSTORM FLOOD FORECASTING AND
EARLY WARNING IN THE KINGDOM OF BHUTAN

The Japanese Detailed Planning Survey Team (hereinafter referred to as "the Team"), organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") and headed by Mr. Shiro Nakasone, visited the Kingdom of Bhutan from October 1 to October 19, 2012, for the purpose of formulating the technical cooperation Project on "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" (hereinafter referred to as "the Project").

During its stay, the Team had a series of discussions and exchanged views on the Project with the Bhutanese authorities concerned. As a result of the discussions, the Team and the Bhutanese authorities concerned agreed on the matters referred to in the document attached hereto.

Thimphu, October 18, 2012

Shiro Nakasone
Leader
Japanese Detailed Planning Survey Team
Japan International Cooperation Agency
(JICA)

Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

ATTACHED DOCUMENT

1. Cooperation plan and implementation arrangement for the Project

The Team and the Bhutanese authorities concerned agreed that the cooperation plan, the implementation arrangement and measures to be taken for the Project will be as described in the Draft "Record of Discussions" (hereinafter referred to as "R/D") shown in ATTACHMENT II.

2. Project Purpose

Both sides agreed that the Project focuses on the capacity development for weather and flood forecasting and early warning against Glacial Lake Outburst Flood (hereinafter referred to as "GLOF") and rainstorm flood.

3. Title of the Project

Both sides agreed to change the title of the Project to "The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan" whose original title was "Development of an Integrated GLOF Early Warning System with Operational Capacity Enhancement for Climate Change Adaptation in Mangdechhu and Chamkharchhu River Basins Project".

4. Target Area

(1) Project site: Thimphu headquarters

(2) Pilot sites: Mangdechhu and Chamkharchhu river basins

5. Cooperation Period of the Project

The cooperation period of the Project will be three (3) years.

6. Procedure before the commencement of the Project

JICA headquarters will undertake the ex-ante evaluation of the Project after the Team returns to Japan and examine the agreed cooperation plan of the Project. In addition, when the Project is considered relevant and viable as a result of the ex-ante evaluation, JICA and the Bhutanese authorities concerned will finalize and sign R/D.

7. Participating organizations of the Project

(1) Implementing Agency

- Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS")

(2) Co-implementing Agencies

- Department of Disaster Management, Ministry of Home & Cultural Affairs (hereinafter referred to as "DDM")
- Department of Geology and Mines, Ministry of Economic Affairs (hereinafter

referred to as "DGM")

- Department of Engineering Services, Ministry of Works and Human Settlement (hereinafter referred to as "DoES")

(3) Japanese Side

JICA will implement the Project with the team of JICA experts.

8. Project Design Matrix

A tentative Project Design Matrix (hereinafter referred to as "PDM") for the Project is shown in ATTACHMENT III.

9. Plan of Operation

A tentative implementation schedule of the Project is shown as the Plan of Operation (hereinafter referred to as "PO") in ATTACHMENT IV.

10, Project Administration

(1) Joint Coordinating Committee (hereinafter referred to as "JCC")

JCC will be organized and meet at least once a year and whenever necessity arises. The following functions will be conducted:

(a) To formulate the annual work plans of the Project;

(b) To review the progress of the annual work plans;

(c) To review and exchange opinions on major issues that may arise during the Project implementation period; and

(d) To discuss any other issues to smoothly implement the Project.

(2) The JCC members

(a) Bhutanese side

- Director of DHMS (Chairperson)
- Representative of DDM
- Representative of DGM
- Representative of DoES
- Representative of GNHC

(b) Japanese side

- Chief Representative of JICA Bhutan Office
- JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

11. JICA's technical cooperation principle

The Team explained the principle of JICA's technical cooperation which pursues capacity development of the counterpart personnel through on-the-job training with JICA experts in the implementation of the Project. Bhutanese side understood the principle of the JICA's technical cooperation.

12. Input from Bhutanese side

Bhutanese side will ensure the following input before the commencement of the Project:

(1) Assignment of counterpart personnel in DHMS, DDM, DGM and DoES;
(2) Office spaces inside the building of DHMS and where JICA experts are expected to be assigned on temporary basis at least during the Project implementation;
(3) Budget allocation for salary for counterpart personnel related to the Project and other expenditure such as transport and travel allowance during the Project;
(4) Budget allocation for running cost of office space (e.g. electricity and water supply, telephone line, internet access etc.) and equipment procured under the Project;
(5) Necessary facility for control station;
(6) Necessary expenses for the data communication of developed information network system; and
(7) Necessary land allocation and permissions for installation of observing and monitoring stations.

13. Others

Both sides agreed the following items:

(1) Installation of equipment

In the Project, some equipment is going to be installed in DHMS and pilot river basins. The installation site and specification of equipment will be defined during the early stage of the Project. Also, necessary staff will be assigned for the operation of the equipment after installation.

(2) Target districts related to Output 3 of the Project

Target districts related to Output 3 of the Project are Trongsa and Bumthang Dzongkhags. If flood risk community is recognized in the implementation process of the Project, however, Zhemgang Dzongkhag might be included as a target district.

(3) Coordination with other development partners

DHMS will ensure the coordination between the Project and assistance by other development partners such as United Nations Development Programme (UNDP) for pursuing synergy effect with each other.

(4) Staff allocation to National Weather, Flood Forecasting and Warning Center

(hereinafter referred to as NWFFWC)

DHMS staff trained in the Project will be assigned as core member of NWFFWC after full operation of NWFFWC in order to ensure the persistent activity of the Project.

(5) Project working group

For the smooth implementation of the Project, DHMS will organize working groups in collaboration with co-implementing agencies and JICA experts tentatively listed as follows;

- Information network;
- Risk assessment;
- Flood and weather forecasting; and
- Early warning and community awareness.

ATTACHMENT I	ATTENDANT LIST
ATTACHMENT II	DRAFT RECORD OF DISCUSSIONS
ATTACHMENT III	PROJECT DESIGN MATRIX (PDM)
ATTACHMENT IV	PLAN OF OPERATION (PO)

ATTACHMENT I

ATTENDANT LIST

Bhutanese side:

Gross National Happiness Commission (GNHC)
- Kuenzang Lham Sangey

Ministry of Economic Affairs
- Sonam Yangley
- Karma Tsering
- Karma Dupchu
- K.Radhakrishnan
- Chimi Dorji
- Tshencho Dorji
- Pema Wangdi

Department of Disaster Management, Ministry of Home and Cultural Affairs (DDM)
- Pelden Zangmo

Japanese side:

Detailed Planning Survey Team, JICA
- Shiro Nakasone, Leader
- Toru Koike, Glacial Lake Outburst Flood
- Yasunori Minagawa, Evaluation Analysis
- Kazuki Kaiya, Planning and Disaster Management Cooperation

JICA Bhutan Office
- Nitta Tomoki, Chief Representative
- Miharu Furukawa, Project Formulation Advisor

ATTACHMENT II

(DRAFT)
RECORD OF DISCUSSIONS

ON

THE PROJECT FOR

CAPACITY DEVELOPMENT OF

GLOF AND RAINSTORM FLOOD FORECASTING AND

EARLY WARNING IN THE KINGDOM OF BHUTAN

AGREED UPON BETWEEN

GROSS NATIONAL HAPPINESS COMMISSION

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, XX XX 2012

Chief Representative of JICA Bhutan	Secretary of Gross National Happiness Commission

Based on the minutes of meetings on the Detailed Planning Survey on the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in The Kingdom of Bhutan (hereinafter referred to as "the Project") signed on 18 October 2012 between Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with DHMS and relevant organizations to develop a detailed plan of the Project.

Both parties agreed the details of the Project and main points discussed as described in the Appendix 1 and the Appendix 2, respectively, and to request their respective governments to proceed with the necessary procedures for implementation of the Project.

Both parties also agreed that DHMS, the counterpart to JICA, will be responsible for the implementation of the Project in cooperation with JICA, coordinate with other relevant organizations and ensure that the self-reliant operation of the Project is sustained during and after the implementation period in order to contribute toward social and economic development of Bhutan.

The Project will be implemented within the framework of the Colombo Plan Technical Cooperation Scheme and the Note Verbales to be exchanged between the Government of Japan (hereinafter referred to as "GOJ") and the Royal Government of Bhutan (hereinafter referred to as "RGoB").

The effectiveness of the record of discussions is subject to the exchange of the Note Verbales.

Appendix 1: Project Description
Appendix 2: Main Points Discussed * To be attached if necessary
Appendix 3: Minutes of Meetings on 18 October 2012

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there is no change in the Project Description agreed on in the minutes of meetings on the concerning Detailed Planning Survey on the Project signed on 18 October 2012 (Appendix 3).

I. BACKGROUND

Bhutan is experiencing the increase in number of disasters related to hydro-meteorological hazards such as flash floods and rainstorm including cyclone (Aila in May 2009) that were not observed before. For instance a record rainfall brought by cyclone Aila has left 12 people dead and damage to infrastructure, and cost the government US$ 15.800 million.

A glacial lake outburst flood (hereinafter referred to as "GLOF") occurs when a body of water that is contained by a glacier or terminal moraine is released. In Bhutan, hazard from GLOF is an urgent environmental and economic issue. Since 1960s, a number of GLOFs have been recorded concurrently with shrink of glaciers and expansion of glacial lakes over the region. The most recent GLOF occurred in October 1994 from the partial burst of the Luggye Tsho in eastern Lunana. This flood caused loss of 21 lives and extensive damage to property along the Punakha- Wangdi valley.

Since the mechanism and event probability of GLOF remains unexplained despite of a number of previous researches, JICA/JST conducted a project "The Study on Glacial Lake Outburst Flood in Bhutan Himalayas" in the period of 2009-2012 to assess GLOF risk in the Mangdechhu River basin, central Bhutan. The project concluded that there is no urgent risk of potential lakes in the basin, which needs to be mitigated by counter measures such as lowering of lake's water level. Considering the catastrophic phenomenon of GLOF, however, the project recommended continuous monitor of glacier lakes as well as development of early warning system in the basin.

With consideration of such situations as mentioned above, Bhutanese government upgraded the Division of Hydro-Met Service to Department and established "National Weather, Flood Forecasting and Warning Center" (hereinafter referred to "NWFFWC") to cope with water related disaster in the country. The hydro-meteorological network in Bhutan has been designed and developed since 1991. However, there is limited or no climate monitoring stations in the northern region where most of the aforementioned disasters have the roots. Moreover, the existing stations are mainly manual operated stations, where data are observed by observers leaving many missing data which are not suitable for climate modeling and related analysis.

In order to meet the natural disasters of hydro-meteorological origins requires adequate multi-tier observation network for in-situ data collection in real or near real time to provide reliable weather forecasting, flood forecasting and warning to safe guard life and property. The current observation network in Bhutan is inadequate in terms of spatial coverage and representativeness.

In response to such background, Bhutanese government requested to Japanese government the Project for establishing early warning system for GLOF and rainfall flood in Mangdechhu and Chamkharchhu.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex XX) and the tentative Plan of Operation (Annex XX).

1. Input

(1) Input by JICA

JICA will take, at its own expense, the following measures according to the normal procedures under the Colombo Plan Technical Cooperation:

(a) Dispatch of Experts

Details of the dispatch of experts are described in Annex III

(b) Training

JICA will receive the Bhutanese personnel connected with the Project for technical training in Japan.

Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

(c) Machinery and Equipment

JICA will provide such machinery, equipment and other materials (hereinafter referred to as "the Equipment") necessary for the implementation of the Project as listed in Annex IV.

In case of importation, the machinery, equipment and other materials under II-1 (1) (c) above will become the property of the RGoB upon being delivered C.I.F. (cost, insurance and freight) to the Bhutan authorities concerned at the ports and/or airports of disembarkation.

Input other than indicated above will be determined through mutual consultations between JICA and DHMS during the implementation of the Project, as necessary.

(2) Input by RGoB

RGoB will take necessary measures to provide at its own expense:

(a) Services of DHMS's counterpart personnel and administrative personnel as referred to in II-2;
(b) Suitable office space with necessary equipment;
(c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
(d) Information as well as support in obtaining medical service;
(e) Credentials or identification cards;
(f) Available data (including maps and photographs) and information related to the Project;
(g) Running expenses necessary for the implementation of the Project;
(h) Expenses necessary for transportation within Bhutan of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and
(i) Necessary facilities to the JICA experts for the remittance as well as

utilization of the funds introduced into Bhutan from Japan in connection with the implementation of the Project

2. Implementation Structure

The roles and assignments of relevant organizations are as follows:

(1) DHMS
  (a) Project Director
    Director of DHMS
  (b) Project Manager
    Head of Hydrology Division, DHMS

(2) Department of Disaster Management, Ministry of Home and Cultural Affairs (hereinafter referred to as DDM)

(3) Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as DGM)

(4) Department of Engineering Services, Ministry of Works and Human Settlements (hereinafter referred to as DoES)

(5) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to DHMS on any matters pertaining to the implementation of the Project.

(6) Joint Coordinating Committee

Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve an annual work plan, review overall progress, conduct monitoring and evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex XX.

3. Project Site(s) and Beneficiaries

(1)Project Site

Thimphu headquarters

(2)Pilot Site

Mangdechhu, Chamkharchhu river basins

(3)Direct Beneficiary

DHMS, DDM, DGM, DoES, Target local government and community in the Project sites

(4)Indirect Beneficiary

Bhutanese people

4. Duration

The cooperation period of the Project will be three (3) years.

5. Reports

DHMS and JICA experts will jointly prepare the following reports in English.

(1) Inception Report at the beginning of the Project

(2) Progress Report on semiannual basis until the project completion

(3) Project Completion Report at the time of project completion

6. Environmental and Social Considerations

(1) RGoB agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations will be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF RGoB

1. RGoB will take necessary measures to:

(1) ensure that the technologies and knowledge acquired by the Bhutan nationals as a result of Japanese technical cooperation contributes to the economic and social development of Bhutan, and that the knowledge and experience acquired by the personnel of Bhutan from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts of third countries performing similar missions in Bhutan under the Colombo Plan Technical Cooperation Scheme.

2. RGoB will take necessary measures to:

(1) provide security-related information as well as measures to ensure the safety of the JICA experts;

(2) permit the JICA experts to enter, leave and sojourn in Bhutan for the duration of their assignments therein and exempt them from foreign registration requirements and consular fees.

(3) exempt the JICA experts from taxes and any other charges on the equipment, machinery and other material necessary for the implementation of the Project;

(4) exempt the JICA experts from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to them and/or remitted to them from abroad for their services in connection with the implementation of the Project; and

(5) exempt taxes and any other charges on the equipment, machinery and other material, referred to in II-1 above, necessary for the implementation of the Project.

3. RGoB will bear claims, if any arises, against the JICA experts resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Project, except when such claims arise from gross negligence or willful misconduct on the part of the JICA experts.

IV. EVALUATION

1. JICA and the RGoB will jointly conduct the following evaluations and reviews.

(1) Mid-term review at the middle of the cooperation term
(2) Terminal evaluation during the last six (6) months of the cooperation term

2. JICA will conduct the following evaluations and surveys to mainly verify sustainability and impact of the Project and draw lessons. The RGoB is required to provide necessary support for them.
   (1) Ex-post evaluation three (3) years after the project completion, in principle
   (2) Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, RGoB will take appropriate measures to make the Project widely known to the people of Bhutan.

VI. MUTUAL CONSULTATION

JICA and RGoB will consult with each other whenever any major issues arise in the course of Project implementation.

VII. AMENDMENTS

The record of discussions may be amended by the minutes of meetings between JICA and RGoB.
The minutes of meetings will be signed by authorized persons of each side who may be different from the signers of the record of discussions.

ANNEX I	PROJECT DESIGN MATRIX (PDM)
ANNEX II	PLAN OF OPERATION
ANNEX III	LIST OF JICA EXPERTS
ANNEX IV	LIST OF EQUIPMENT
ANNEX V	LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
ANNEX VI	LIST OF COUNTERPARTS

ANNEX III

LIST OF JICA EXPERTS
(Tentative)

Fields of experts to be covered by the Japanese experts are as follows:

1. Watershed Disaster Management (Chief Advisor)
2. Meteorology / Climate Change Adaptation
3. Hydrology / Glaciology
4. Flood Hazard Map / GIS
5. Weather Forecasting
6. Information Network / EWS
7. Community Disaster Management

ANNEX IV

LIST OF EQUIPMENT
(Tentative)

1. Equipment related to early warning system
2. Office equipment
3. Other equipment mutually agreed upon as necessary for the implementation of the Project

ANNEX V

LIST OF PROPOSED MEMBERS OF JOINT COORDINATING COMMITTEE
(Tentative)

1. Bhutanese side
    - Director of DHMS (Chairperson)
    - Representative of DDM
    - Representative of DGM
    - Representative of DoES
    - Representative of GNHC

2. Japanese side
    - Chief Representative of JICA Bhutan Office
    - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides.

Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

ANNEX VI

LIST OF COUNTERPARTS
(Tentative)

1. DHMS
   Karma Dupchu, Hydrology Division
   Pema Wangdi, Hydrology Division
   Sangay Tenzin, Hydrology Division
   Chhimi Dorji, Planning, Coordination and Research Division
   Tshencho Dorji, Meteorology Division
   Tayaba Tamang, Meteorology Division
   Sangay Tashi, IT officer

2. DDM
3. DGM
4. DoES
   Kelzang Nima, Flood Management Division

The rest of member will be confirmed by signing of R/D

Appendix 2

MAIN POINTS DISCUSSED

(Tentative)

ATTACHMENT III

Tentative Project Design Matrix (PDM0)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan
Project Duration: (3 years)
Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan
Target Group : DHMS, DDM, DGM, DoES, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated to relevant agencies at central and local level.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. b. GLOF/rainstorm flood risk zonation maps are developed. c. Flood and weather forecasting is daily delivered utilizing improved forecasting system. d. SOP on emergency information sharing is developed.	a. Project documents b. The zonation maps c. SOP at central level	- Staff of DHMS, DGM, DoES and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

Activities	Input		
	【Japanese side】	【Bhutan side】	
<Output 1> 1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform. 1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system. 1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES. 1-4. Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM and DoES staff. 1-5. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value). 1-6. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies. <Output 2> 2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood. 2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS. 2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing. 2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools. 2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance. <Output 3> 3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents. 3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2. 3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins. 3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.	(1) Dispatch of Experts Experts(7): - Watershed Disaster Management (Chief Advisor) - Meteorology / Climate Change Adaptation - Hydrology / Glaciology - Flood Hazard Map / GIS - Weather Forecasting - Information Network / EWS - Community Disaster Management (2) Provision of equipment - Detailed contents will be determined through the implementation of the Project. (3) C/P Training in Japan (4) Local cost shared by Japanese side - If necessity arises	(1) Counterpart(C/P) personnel - Project Director - Project Manager - Counterparts (2) Office space and facilities for the Project - Office space / facilities - Electricity, Water supply and Internet connection (3) Necessary data - Geometric data - Hydro-Meteorological data - Socio-economic data etc. (4) Necessary arrangement - Land allocation for EWS (5) Local cost shared by Bhutan side	- Necessary budget for the Project is allocated without any significant delay. - Necessary equipment for the Project is procured without significant delay. [Pre-condition] Political situation of Bhutan is stable.

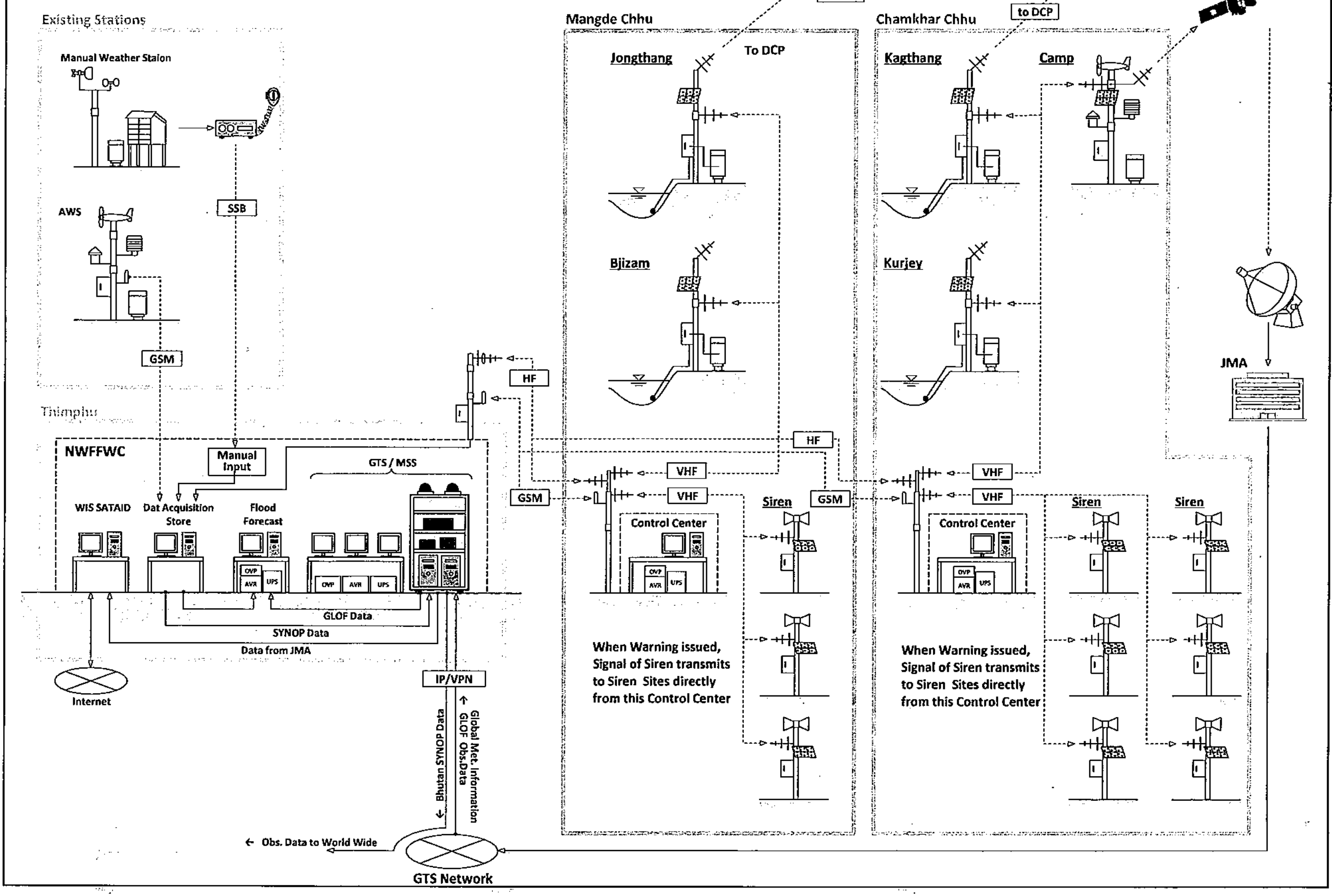
Tentative Plan of Operation (PO0)

ATTACHMENT IV

	1st Year	2nd Year	3rd Year
Output 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.			
[1-1] Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.	■		
[1-2] Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.	■	■	
[1-3] Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate chance in corroboration with DGM and DoES.	■		
[1-4] Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM and DoES Staff.	■	■	■
[1-5] Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).	■	■	■
[1-6] Develop standard operation procedure manuals on emergency information sharing through discussion and workshops with relevant agencies.			■
Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.			
[2-1] Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood.	■		
[2-2] Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.	■		
[2-3] Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.	■		
[2-4] Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.	■	■	
[2-5] Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.		■	■
Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.			
[3-1] Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.		■	
[3-2] List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2.		■	
[3-3] Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.			■
[3-4] Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.			■

ATTACHMENT VI

CONCEPT OF NETWORK SYSTEM



ATTACHMENT VII

PERSONNEL PLAN OF DHMS

Division and its Duty on the Project	Recommended Staff Members	Extension Plan of Staff Members on this Project until the completion of this Project
Meteorology and Hydrology Divisions ① 24 hours Operation ② Issue Warning	{Forecaster(1)+Technician(3)} ×4 Group +Day duty(2) =18 staff	{forecaster(1)+Technician (2)} ×3 Groups +Day duty(2) =11 staff
Telecommunication and Instrument Division ① 24 hours monitoring of GTS/MSS ② Management of other related Instruments ③ Data input of Synop data from Local Observatories	{(Engineer +Technician) (3) ×4 groups} +Day duty(1) =13 staff	{(Engineer +Technician) (3) ×3 groups} +Day duty(1) =10 staff
Travelling Maintenance Group ① Regular maintenance once/month for every local sites ② Maintenance /repair in case of Instrument failure ③ Instruments to be maintained : Hydro-Met Observation system, Siren system, Transmit system related to JICA Project	{(Travelling Maintenance staff) (2) ×2 Groups}+{Staff of H/Q (2)} =6 staff	*(DHMS already have Travelling maintenance group: one group=2～3staff for ① & ② below)* ① Annual maintenance ② Data down load/Maintenance (Once /2～3 months) Existing Travelling Group also maintains the instruments to be installed in this Project. Adding, one more maintenance (shown below) is carried out by 1 (one) staff ③ Monthly maintenance for all instruments of this Project
Control Center ①24 hours operation of Observation ②Management of instruments ④ Distribution of Warning Information, if needed	{(Observers (3)×3 Groups) +OIC(1)}×2 Stations=20 staff	{(Observers(2)×3 Groups) + OIC (1)}×2 Stations=14 staff members

Appendix 2

Project PDM and PO

Project Design Matrix (PDM)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan

Project Duration: (3 years)

Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan

Target Group: DHMS, DDM, DGM, DoES, NLCS, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated based on accumulation of hydro-met data to relevant agencies at central and local level as well as outside of pilot river basin. b. Evacuation drills are conducted at least one community outside of pilot river basin with EWS.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Plan of institutional strengthening for mainstreaming disaster risk assessment information into development plans is formulated. b. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. c. GLOF/rainstorm flood risk zonation maps are developed. d. Flood and weather forecasting is delivered daily by utilizing improved forecasting system. e. SOP on emergency information sharing is developed.	a. Plan of Institutional strengthening b. Project documents c. The zonation maps d. DHMS weather forecasting and warning report e. SOP at central level	- Staff of DHMS, DGM, DoES , NLCS and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

<table>
<tr><th>Activities</th><th colspan="2">Input</th><th></th></tr>
<tr>
<td rowspan="2"><Output 1>
1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.
1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.
1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.
1-4. Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector.
1-5. Prepare and improve GLOF/rainstorm flood risk zonation to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLCS staff.
1-6. Foster the sense of land use management among related agencies through workshops etc.
1-7. Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans.
1-8. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).
1-9. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies.
<Output 2>
2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood.
2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.
2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.
2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.
2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.
<Output 3>
3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.
3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-5, 2-2.
3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.
3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.</td>
<td rowspan="2">【Japanese side】
(1) Dispatch of Experts
Experts(7):
- Watershed Disaster Management (Chief Advisor)
- Meteorology / Climate Change Adaptation
- Hydrology / Glaciology
- Flood Hazard Map / GIS
- Weather Forecasting
- Information Network / EWS
- Community Disaster Management
(2) Provision of Equipment
- Detailed contents will be determined through the implementation of the Project.
(3) C/P Training in Japan
(4) Local cost shared by Japanese side
- If necessity arises</td>
<td rowspan="2">【Bhutanese side】
(1) Counterpart(C/P) personnel
- Project Director
- Project Manager
- Counterparts
(2) Office space and facilities for the Project
- Office space / facilities
- Electricity, Water supply and Internet connection
(3) Necessary data
- Geometric data
- Hydro-Meteorological data
- Socio-economic data etc.
(4) Necessary arrangement
- Land allocation for EWS
(5) Local cost shared by Bhutanese side</td>
<td>- Necessary budget for the Project is allocated without any significant delay.
- Necessary equipment for the Project is procured without significant delay.</td>
</tr>
<tr><td>[Pre-condition]
Political situation of Bhutan is stable.</td></tr>
</table>

Tentative Plan of Operation (PO0)

	1st Year	2nd Year	3rd Year
Output 1: Capacity of NWFFWC on GLOF/rainstorm flood risk assessment, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.			
[1-1] Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform.	■		
[1-2] Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system.	■	■	
[1-3] Review previous studies including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES.	■		
[1-4] Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector.	■		
[1-5] Prepare and improve GLOF/rainstorm flood risk zonation maps to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLC staff.	■	■	■
[1-6] Foster the sense of land use management among related agencies through workshops etc.	■	■	■
[1-7] Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans.		■	■
[1-8] Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value).	■	■	■
[1-9] Develop standard operation procedure manuals on emergency information sharing through discussion and workshops with relevant agencies.			■
Output 2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.			
[2-1] Review existing hydro-meteorological network and planned hydropower plants from the view point of administrative response on GLOF/rainstorm flood.	■		
[2-2] Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS.	■		
[2-3] Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing.	■		
[2-4] Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools.	■	■	
[2-5] Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance.		■	■
Output 3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.			
[3-1] Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents.		■	
[3-2] List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-4, 2-2.		■	
[3-3] Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins.			■
[3-4] Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.			■

Appendix 3

Counterpart List

Project Counterpart List

Main Counterpart Agency (DHMS)

Name	Division	Position
Mr. Karma Tsering	DHMS	Director, Project Director
Mr. Karma Dupchu	Hydrology Division	Division Chief, DHMS, Project Manager
Mr. Pema Wangdi	Hydrology Division	Engineer, Deputy Project Manager
Mr. PP Sharma	Hydrology Division	Executive Engineer
Mr. Sangay Tenzin	Hydrology Division, FWS	Engineer
Ms. Kuenzang	Hydrology Division, FWS	Engineer
Mr. Kush Rai	Hydrology Division, FWS	Engineer
Mr. Ajay Pradham	Hydrology Division	
Mr. Bikash Pradhan	Hydrology Division	Engineer/Hydro-met officer
Mr. Tandin Wangchuk	Hydrology Division	Asst, Engineer
Mr. Manila	Hydrology Division	Sr. Hydro-met Technician
Mr. Ngawang Namgyal	Hydrology Division	ICT Technician
Ms.Passang Gyem	Hydrology Division	Technician
Mr. Jigme Wangdi	Hydrology Division	Technician
Mr. Tayba Buddha Tamang	Meteorology Division	Offig. Chief of Division
Mr. Kinzang Sonam	Meteorology Division	Chief Meteorologist
Mr. Chhmi Wangda	Meteorology Division	Asst, Meteorologist Officer
Mr. Sonam Tashi	Meteorology Division	Forecaster
Mr. Tshering Pelior	Meteorology Division	Forecaster
Mr.Phurba	Meteorology Division	Forecaster
Mr.Ranjit Tamang	Meteorology Division	Forecaster
Ms.Pema Syeldon	Meteorology Division	Engineer
Mr.Jangchup Chophel Dorji	Meteorology Division	Engineer
Mr. Karma Tshewang	Meteorology Division	Junior Engineer
Mr. Karma Tenzin	Meteorology Division	Chief Technician
Mr. Ranjit Tamang	Meteorology Division	Met Technician
Mr. Phub Phurba	Meteorology Division	Met Technician
Mr. Cheki Dorj	Meteorology Division	Technician
Mr. Norbu Wangdi	Meteorology Division	Technician

Mr.Thinley Wanghuk	Meteorology Division	Technician
Mr. Phuntsho Namgyal	PCRD	Division Chief
Mr. Sangay Tashi	PCRD	ICT Officer
Mr. Tshewang Rinzin	PCRD	Engineer
Ms. Dema Yangzom	PCRD	Engineer
Mr. Tsering Tashi	Snow & Glacier Division	Offtg. Chief of Division
Mr. Ngawang Namgyal	ICT	Hydro-met Technician
Mr. Sonam Chedup	MOEA	Head ICT Division

Sub Counterpart Agencies

Name	Organization	Position
Mr. Jigme Chogyal	DDM, MHCA	Program Officer
Mr. Tsering Penjore	DGM, MoEA	Executive Geologist
Ms. Thinley Choden	FEMD, DoES, MoWHS	Executive Engineer
Mr. Tashi Phuntsho	FEMD, DoES, MoWHS	Dy. Ex. Engineer
Ms. Kuenzang Choden	FEMD, DoES, MoWHS	Engineer
Mr. Nima Tshering	Topographic Division, NLC	Head/Chief
Ms. Tashi Wangmo	DHS, MoWHS	Chief of Survey and GIS

Pilot Project Area (Mangdechhu River Basin)

Name	Organization	Position
Mr. Jamyang Chojuy	Trongsa District Office	District Disaster Management Officer
Ms. Sangay Choden	Mangdechhu CNC, DHMS	EWS Operator
Mr. A.C.Ghimiray	MHPA	
Mr. Norbu Sa Foreslei	MHPA	

Pilot Project Area (Chamkharchhu River Basin)

Name	Organization	Position
Mr. Tshewang Dorji	Bumthang District Office	District Disaster Management Officer
Mr. Dungchu Wangdi	Kurjey, DHMS	Hydrological Observer

Mr. Tashi Tenzin	Kurjey, DHMS	Hydrological Observer

Mainstreaming Disaster Risk Reduction Working Group（MDRR W/G）

Name	Organization	Position
Mr. Karma Dupchu	HD, DHMS	Chief Hydrology Officer
Mr. Phuntsho Namgyal	PCRD, DHNS	Chief of PCRD
Mr. Tsering Tashi	SGD, DHMS	Engineer
Mr. Bikash Pradhan	HD, DHMS	Engineer/Hydro-met officer
Ms. Dema Yangzom	PCRD, DHMS	Engineer
Mr. Jigme Chogyel	DDM, MHCA	Program Officer
Mr. Tshering Penjore	DGM	Ex. Geologist
Ms. Thinley Choden	FEMD, DoES, MoWHS	Ex. Engineer
Mr. Tashi Phuntsho	FEMD, DoES, MoWHS	Dy. Ex. Engineer
Mr. Tshering Penjor	NLCS	Chief Survey Engineer
Mr. Tenzin Norbu	NLCS	Survey Engineer
Mr. Sonam Dendup	NLCS	DCSE
Ms. Tashi Wangmo	DHS, MoWHS	Chief Urban Planner
Mr. Yasuhiko Kato	JICA Expert	Chief Advisor/ Basin Disaster Management Planning

Flood Hazard Map Working Group（FHM W/G）

Name	Organization	Position
Mr. Karma Dupchu	HD, DHMS	Chief Hydrology Officer
Mr. Bikash Pradhan	HD, DHMS	Engineer/Hydro-met officer
Mr. Jigme Wangdi	HD, DHMS	Technician
Mr. Somik Mukherjee	FWS, HD, DHMS	HEAD/TMO
Mr. Sangay Tenzin	FWS, HD, DHMS	AE-I
Mr. Kuenzang	FWS, HD, DHMS	AE-II
Mr. Kush Rai	FWS, HD, DHMS	Engineer
Mr. Chhimi Dorji	SGD, DHMS	Ex. Engineer
Mr. Tshering Wangchuk	SGD, DHMS	Engineer
Mr. Tayba Buddha Tamang	MD, DHMS	Dy. Ex. Engineer
Mr. Sonam Rabten	MD, DHMS	Engineer

Mr. Phuntsho Namgyel	PCRD, DHMS	Chief
Mr. Tshewang Rinzin	PCRD, DHMS	Engineer
Mr. Jigme Chogyel	DDM, MHCA	Program Officer
Mr. Tshering Penjore	DGM	Ex. Geologist
Mr. Lalit Kr. Chhetri	DGM	MPO
Ms. Thinley Choden	FEMD, DoES, MoWHS	Ex. Engineer
Mr. Tashi Phuntsho	FEMD, DoES, MoWHS	Dy. Ex. Engineer
Mr. Kinley Dorji	FEMD, DoES, MoWHS	Dy. Ex. Engineer
Mr. Jigme Phuntsho	FEMD, DoES, MoWHS	Dy. Ex. Engineer
Ms. Kuenzang Choden	FEMD, DoES, MoWHS	Engineer
Mr. Megnath Neopaney	FEMD, DoES, MoWHS	Engineer
Mr. Pema Cheda	FEMD, DoES, MoWHS	Engineer
Mr. Sonam Dendup	NLCS	Engineer
Ms. Tashi Wangmo	DHS, MoWHS	Chief Urban Planner
Mr. Tomoyuki Wada	JICA Expert	Flood Hazard Map/ GIS

Appendix 4

Minutes of Meetings of Inception Report

MINUTES OF MEETINGS ON INCEPTION REPORT FOR THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

AGREED UPON BETWEEN
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, October 18, 2013

加藤泰彦

Mr. Yasuhiko Kato
Chief Advisor, Expert Team
Japan International Cooperation Agency
(JICA)

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

In response to the request of the Government of Kingdom of Bhutan, the Government of Japan has decided to conduct the technical cooperation concerning the "Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning"(hereinafter referred to as "the Project"). The Japanese side and the Bhutanese side came to an agreement on the Record of Discussion (hereinafter referred to as "R/D") which was signed on 14 May 2013 between Gross National Happiness Commission and Japan International Cooperation Agency (hereinafter referred to as "JICA").

Based on the R/D, JICA dispatched the Expert Team (hereinafter referred to as "the Team") headed by Mr. Yasuhiko Kato from 9 October 2013 for the commencement of the Project. The Team held a meeting with the officials of Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and other authorities concerned with the Project and explained the contents of the Inception Report (hereinafter referred to as "IC/R"). The list of the participants is attached as Annex 1.

The IC/R was accepted by the Bhutanese side in principle. The following are the main points discussed and agreed by the both sides.

1. Implementation of the Project

   The Team explained and the Bhutanese side understood that the Project will be implemented by the Bhutanese initiative and supported by the Team.

2. Role of DHMS in the Project

   DHMS, the main counterpart agency of the Project, takes the leadership of the Project implementation in collaboration with other authorities concerned and assumes overall responsibility for replicating and developing the Project outputs to other basins in Bhutan after completion of the Project.

3. Involvement of Sub-counterpart Agencies

   DHMS shall closely collaborate with the following sub-counterpart agencies to implement smooth cooperative Project activity and to mainstream disaster risk assessment into development.

   - Department of Disaster Management, Ministry of Home & Cultural Affairs (hereinafter referred to as "DDM")
   - Department of Geology and Mines, Ministry of Economic Affairs (hereinafter referred to as "DGM")
   - Department of Engineering Services, Ministry of Works and Human Settlement (hereinafter referred to as "DoES")
   - National Land Commission Secretariat (hereinafter referred to as "NLCS")
   - Department of Human Settlement, Ministry of Works and Human Settlements ((hereinafter referred to as "DHS")

4. Establishment of Joint Coordinating Committee

DHMS intends to organize the Joint Coordinating Committee (JCC) soon in accordance with the R/D as shown in Annex 2

5. Nomination of Counterpart Personnel

The Team requested the Bhutanese side to assign enough number of counterparts for respective Project activities. The Bhutanese side agreed to assign the counterparts as shown in Annex 3.

6. Arrangement of Office for the Team

The Team requested DHMS to arrange an office and facilities required for the Team. DHMS agreed to prepare the working space for each expert in DHMS.

7. Land Allocation to Install Early Warning System

The Team requested DHMS to allocate the land to install the equipment and facilities for Early Warning Systems (EWS) in two pilot basins as soon as the installation sites are decided in order to meet the installation work schedule and to secure sustainable long-term operation. DHMS agreed to allocate the land in consultation with relevant agencies and local government after identification of project infrastructures sites (i.e. location of AWS, AWLS and sirens etc.)

8. Participation of Local Administration as a JCC member

DDM commented that the local governments of both pilot river basins shall be invited as a member of JCC, considering implementation and sustainability of the project activities. It shall be discussed with the local governments during the visit to the sites from October 20 to November 3, 2013.

9. Participation of DHS as Sub-counterpart Agency and JCC member

The Team proposed Department of Human Settlement, Ministry of Works and Human Settlements (hereinafter referred to as "DHS") to participate the Project as Sub-counterpart agency as well as a member of JCC, since DHS is responsible for regional development planning including land use. The Bhutanese side agreed to have DHS as Sub-counterpart agency and JCC member.

10. Roles on Flood Hazard Map

The Team responded to the query from DDM, the role and mandate on flood risk assessment and flood hazard mapping in the Project is still draft. It will be determined through baseline survey and will be decided in the first JCC in January 2014. DDM will share currently prepared survey result to the Team for this purpose.

11. Coordination with NAPA II Project

DHMS commented that it is important to make sure the Project and NAPA II synchronize nicely. The Team agreed to consider it.

12. Project Implementation Schedule for Each Relevant Agency

DHMS requested the project implementation schedule for each relevant agency to know which agency will be involved at which moment to work with the experts of the Team. The Team replied that the schedule will be prepared and shared at the first JCC in January 2014.

13. Next Meeting

The first JCC meeting will be held at the end of January, 2014. The followings are the main issues to be discussed:

(1) to report the progress of the Project activities to JCC members,
(2) to agree on the specifications of the equipment and facilities related to the EWS to be installed,
(3) to define the objectively verifiable indicators in the Project Design Matrix (PDM) tentatively set as attached in R/D, in view of the results of the baseline survey to be carried out,
(4) to present and agree on the work plan, and
(5) to define and fix each role and responsibility for all counterpart agencies.

Annex-1

List of the Participants of IC/R Meetings

Bhutanese Side:

Mr. Karma Tsering	Director, DHMS
Mr. Karma Dupchu	Chief of Hydrology Division, DHMS
Mr. Singay Dorji	Chief of Meteorology Division, DHMS
Mr. Chhimi Dorji	Offtg. Chief of Snow & Glacier Division, DHMS
Mr. Phuntsho Namgyal	Offtg. Chief of Planning Coordination Division, DHMS
Mr. Pashupati Sharma	Executive Engineer of Hydrology Division, DHMS
Mr. Manila	Sr. Hydro-met Technician, DHMS
Ms. Peiden Zangmo	Chief Program Officer, DDM
Mr. Chencho Tshering	Program Officer, DDM
Mr. Jigme Chogyal	Program Officer, DDM
Mr. Tshring Penjore	Executive Geologist, DGM
Ms. Thinley Choden	Executive Director, DoES
Mr. Tenzin Norbu	Survey Engineer, NLCS
Mr. Ugyen M Tenzin	Chief of Urban Planning, Regional Planning Division, DHS
Ms. Tashi Wangmo	Dy. Chief of Urban Plannin, DHS
Mr. Rinchen Wangdi	Chief Program Coordinator, GNHC
Ms. Kuenzang L. Sangey	Dy. Chief Program Coordinator, GNHC
Mr. Karma Tsheing	Reporter, BBS
Ms. Tsheriny Yangzam	Reporter, Kuensel

Japanese Side:

Mr. Koichi Kitamura	Program Officer, Disaster Management Division 1, Water Resources and Disaster Management Group, Global Environment Department, JICA HQ
Ms. Yumiko Asakuma	Chief Representative, JICA Bhutan Office
Mr. Yasuhiko Kato	Chief Advisor/ Basin Disaster Management Planning
Mr. Toru Koike	Vice Chief Advisor/ Flood Forecasting and Warning
Mr. Shigeo Suizu	Meteorology/ Hydrology
Mr. Tetsuro Fukui	ICT/ Early Warning System Planning
Ms. Kaoru Sasaoka	CBDRM 2/ Training

Annex-2

List of Members of Joint Coordinating Committee (JCC)

1. Bhutanese side
    - Director of DHMS (Chairperson)
    - Representative of DDM
    - Representative of DGM
    - Representative of DoES
    - Representative of NLCS
    - Representative of DHS
    - Representative of GNHC

2. Japanese side
    - Chief Representative of JICA Bhutan Office
    - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides. Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

Annex-3

List of Counterparts

(Tentative)

1. DHMS
   Karma Dupchu, Hydrology Division
   Pema Wangdi, Hydrology Division
   Sangay Tenzin, Hydrology Division
   Chhimi Dorji, Planning and Research Division
   Tshencho Dorji, Meteorology Division
   Tayaba Tamang, Meteorology Division
   Sangay Tashi, IT officer
2. DGM
3. DGM
4. DoES
   Kelzang Nima, Flood Management Division
5. NLCS
6. DHS

The rest of the member will be confirmed by first JCC.

Appendix 5

Minutes of Meetings of 1st Joint Coordinating Committee (JCC) Meeting

MINUTES OF MEETINGS ON FIRST JOINT COORDINATING COMMITTEE FOR THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

AGREED UPON BETWEEN
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, February 10, 2014

加藤泰彦

Mr. Yasuhiko Kato
Chief Advisor, Expert Team
Japan International Cooperation Agency
(JICA)

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

In response to the request of the Government of Kingdom of Bhutan, the Government of Japan has decided to conduct the technical cooperation concerning the "Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning"(hereinafter referred to as "the Project"). The Japanese side and the Bhutanese side came to an agreement on the Record of Discussion (hereinafter referred to as "R/D") which was signed on 14 May 2013 between Gross National Happiness Commission (hereinafter referred to as "GNHC") and Japan International Cooperation Agency (hereinafter referred to as "JICA"). Based on the R/D, JICA dispatched the Expert Team (hereinafter referred to as "the Team") headed by Mr. Yasuhiko Kato from 9 October 2013 for the commencement of the Project.

The Team and the officials of main counterpart agency, Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and sub-counterpart agencies with GNHC discussed the progress of the Project activities at the First (1st) Joint Coordinating Committee (hereinafter referred to as "JCC") on 7 February 2014. The list of the 1st JCC participants is attached as Annex 1. The following are the main points discussed and agreed by the both sides.

1. Progress of the Project Activities

   The progress of the Project activities which were carried out for around four months from October 2013 to January 2014 by predominantly the counterpart personnel with support from the Team was agreed upon and accepted by the Bhutanese side in principle.

2. Participation of District Disaster Focal Person as JCC member

   After the discussion between DHMS, the Team and the District governments of both pilot river basins in 2013, it was agreed that the District disaster focal person will participate in JCC as a regular member, considering smooth implementation and sustainability of the Project activities. Accordingly disaster focal persons of Trongsa and Bumthang Districts attended the 1st JCC. The revised JCC member list is attached as Annex 2.

3. Nomination of Counterpart Personnel

   The Bhutanese side assigned the counterpart personnel as shown in Annex 3 upon the request from the Team.

4. Specifications of EWS Related Equipment and Facilities

   The Team explained the outline of the technical specification of the Early Warning System (hereinafter referred to as "EWS") related equipment and facilities to be procured and installed such as 1) GTS/MSS for NWFFWC and 2) EWS for two pilot river basins. The Bhutanese side agreed on and approved the specification in principle.

5. Appropriateness of the Indicators in the PDM

   The Team reviewed the "objectively verifiable indicators" of the Project Design Matrix (PDM) tentatively set as attached in R/D through baseline survey. As a result, the Team proposed not to revise the indicators in view of their appropriateness proved through the survey. The Bhutanese side agreed on that. The PDM of the Project is attached as Annex 4.

6. Project Implementation Schedule for Each Counterpart Agency

The team prepared the project implementation schedule for each counterpart agency to know which agency will be involved at which moment to work with the experts of the Team upon the request of DHMS. The Bhutanese side basically agreed on that. The schedule is attached as Annex 5.

7. Coordination with Ministry of Information and Communication

DDM recommended that the Team contact and coordinate with Ministry of Information and Communication (MoIC) about the EWS specification related to information and communication part at an early date. The Team agreed to coordinate with MoIC.

8. Location of EWS Control Centers

DDM commented that the EWS control centers are desirable to be located closer to District office in administrative view. The Team and DHMS replied that the proposed location of the EWS control centers have been identified in consideration of the certainty of VHF communication and the usage of existing facilities. DDM understood and agreed on that.

9. Progress of Formalities on Land Allocation for EWS Facilities

The Team and DHMS reported the progress and status of necessary formalities on land allocation for five automatic water level stations (AWLS) and nine flood warning sirens in the pilot basins. All the participants understood it.

10. Next Meeting

At the end of September 2014, next meeting will be held to explain and discuss the Progress Report (1) compiling all the Project activity results from October 2013 to September 2014.

Annex-1

1st JCC Participant List

Bhutanese Side:

Mr. Karma Tsering	Director, DHMS
Mr. Karma Dupchu	Chief of Hydrology Division, DHMS
Mr. Singay Dorji	Chief of Meteorology Division, DHMS
Mr. Chhimi Dorji	Offtg. Chief of Snow & Glacier Division, DHMS
Mr. Phuntsho Namgyal	Offtg. Chief of Planning Coordination Division, DHMS
Mr. K. Radhakrishnan	TMO, FWS, DHMS
Mr. Manila	Sr. Hydro-met Technician, DHMS
Mr.Chhedor Wangdi	Director, DDM
Mr. Jigme Chogyal	Program Officer, DDM
Mr. Norio Onjo	GIS Unit, DDM
Mr. Tshring Penjore	Executive Geologist, DGM
Ms. Kuenzang Choden	Engineer, DoES
Mr. Tshering Penjor	Chief of Topography, NLCS
Mr. Ugyen M Tenzin	Chief of Urban Planning, Regional Planning Division, DHS
Ms. Kuenzang L. Sangey	Dy. Chief Program Coordinator, GNHC
Mr. Jamyang Chojay	Disaster Focal Person, Trongsa District
Mr. Tshewang Dorji	Disaster Focal Person, Bumthang District

Japanese Side:

Ms. Yumiko Asakuma	Chief Representative, JICA Bhutan Office
Ms. Miharu Furukawa	Representative, JICA Bhutan Office
Mr. Yasuhiko Kato	Chief Advisor/ Basin Disaster Management Planning
Mr. Toru Koike	Vice Chief Advisor/ Flood Forecasting and Warning
Mr. Shigeo Suizu	Meteorology/ Hydrology
Mr. Tetsuro Fukui	ICT/ Early Warning System Planning
Mr. Tomoyuki Wada	Flood Hazard Map/ GIS

Annex-2

Joint Coordinating Committee (JCC) Member List (Revised)

1. Bhutanese side
   - Director of DHMS (Chairperson)
   - Representative of DDM
   - Representative of DGM
   - Representative of DoES
   - Representative of NLCS
   - Representative of DHS
   - Representative of GNHC
   - Representative of Trongsa District (Mangdechhu basin)
   - Representative of Bumthang District (Chamkharchhu basin)

2. Japanese side
   - Chief Representative of JICA Bhutan Office
   - JICA Experts

Note: Member of JCC is (are) subject to change when necessity arises based on mutual consultation between Japanese and Bhutanese sides. Representative(s) of the Embassy of Japan in India may participate in the JCC as observer(s).

Annex-3

Counterpart List

***Project Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning in the Kingdom of Bhutan* funded by JICA under TCP**
(Oct 2013- Sep. 2016)

List of Counterparts to JICA Experts from DHMS, MoEA

Sl #	**Name**	**Counterparts from DHMS**	[redacted]	**Remarks**
1	Mr. YASUHIKO KATO, Chief Advisor/Basin Disaster Management Planning	1. Karma Dupchu, Chief, Hydrology Division (HD),	[redacted]	Relevant counterparts will be assigned or attached depending on need and for what purpose
		2. Mr. Singye Dorji, Chief, Meteorology Division (MD) Singay	[redacted]	
		3. Mr. Phuntsho Namgyal, Chief, Planning Coordination and Research Division (PCRD)	[redacted]	
		4. Mr. Chhimi Dorji, Chief, Snow and Glacier Division, DHMS 5. Tshering Tashi, Engineer, SGD,DHMS	[redacted]	
2	Mr. TORU KOIKE, Vice Chief Advisor/Flood Forecasting and Warning	1. Karma Dupchu, Chief HD, DHMS 2. Mr. Sangay Tenzin, Engineer, FWS, HD, 3. Tshering Tashi, Engineer, SGD,DHMS	[redacted]	
3	Mr. TETSURO FUKUI, ITC/Early Warning System Planning	1. Mr. Sangay Tashi, ICT Officer, PCRD,	[redacted]	
		2. Mr. Sangay Tenzin, Engineer, FWS, HD,	[redacted]	
		3. Mr. Kunzang, Engineer, FWS, HD,	[redacted]	
		4. Mr. Kush Rai, Engineer, FWS, HD,	[redacted]	
		5. Mr. Chhimi Wangda, Asst. Meteorological Officer, MD.	[redacted]	
		6. Tshering Tashi, Engineer, SGD ,DHMS	[redacted]	
4	Mr. SHIGEO SUIZU, Meteorology& Hydrology Expert	**Related to Meteorology:** 1. Mr. Singay Dorji, Chief, Meteorology Division ,DHMS 2. Mr. Tayba Buddha Tamang, Meteorologist, MD.	[redacted]	
		Related to Hydrology: 1. Karma Dupchu Chief, HD, 2. Mr. Sangay Tenzin, Engineer, FWS, HD, 3. Mr. Ajay Pradhan, HD, 4. Mr. Manila, Sr. Hydro-met Technician, HD.	[redacted]	

		DHMS	[redacted]	
5	Mr. Tomoyuki Wada, Flood Hazard map/GIS	1. Mr. Phuntsho Namgyal, PCRD 2. Mr. PP Sharma, Executive Engineer, HD, 3. Mr. Tshewang Rinzin, Engineer, PCRD 4. Mr. Pema Wangdi, Engineer, HD(on study)	[redacted]	
6	Ms. Lolita C Garacia, CBDRM Expert	1. Mr. Phuntsho Namgyal, Chief, PCRD 2. Ms. Dema Yangzom, Engineer, PCRD	[redacted]	DHMS counterparts role under CBDRM is to provide technical backstopping and lead role will be taken by DDM, MoHCA
7	Ms. KAORU SASAOKA, CBDRM/Training	1. Mr. Phuntsho Namgyal, Chief, PRCD 2. Ms. Dema Yangzom, Engineer, PCRD	[redacted]	DHMS role under CBDRM is to provide technical backstopping and lead role will be taken by DDM, MoHCA
8	Mr...................... Meteorological Forecasting	Singay 1. Mr. Singye Dorji, Chief, MD 2. Mr. Tayba Buddha Tamang, Meteorologist, MD, 3. Mr. Sonam Dorji, Meteorologist, MD,	[redacted]	

Note:
MoEA : Ministry of Economic Affairs
DHMS : Department of Hydro-met Services
HD : Hydrology Division
MD : Meteorology Division

PCRD : Planning Coordination and Research Division
SGD : Snow and Glacier Division
FWS : Flood Warning Section

Signed by

(Karma Dupchu)
Chief, HD, DHMS

(Singye Dorji)
Chief, MD, DHMS

(Phuntsho Namgyal)
Chief, PCRD, DHMS

(Chhimi Dorji)
Chief, SGD, DHMS
SGD

Endorsed by:

Director, DHMS

Project Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning in the Kingdom of Bhutan funded by JICA under TCP
(Oct 2013- Sep. 2016)

List of Counterparts to JICA Experts from Sub-counterpart Agencies

Sl #	Name	Agency/Organization	Position	[redacted]
1	Mr. Nima Tshering	Topographic Division, National Land Commission (NLC)	Head/Chief	[redacted]
2	Mr. Tsering Penjore	Department of Geology and Mines (DGM), Ministry of Economic Affairs (MoEA)	Executive Geologist	[redacted]
3	Ms. Thinley Choden	Flood Engineering Management Division, Department of Engineering Services, Ministry of Works and Human Settlement (MoWHS)	Executive Engineer (EE)	[redacted]
4	Mr. Jigme Chogyal	Department of Disaster Management Ministry of Home and Cultural Affairs (MHCA)	Program Officer	[redacted]
5	Ms. Tashi Wangmo	Department of Human Settlements, Ministry of Works and Human Settlements (MoWHS)	Dy. Chief of Urban Planning	[redacted]

Annex-4

Project Design Matrix (PDM) of the Project

ANNEX I

Tentative Project Design Matrix (PDM)

Project Title: Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan

Project Duration: (3 years)

Project Site: Mangdechhu and Chamkharchhu River Basins in Kingdom of Bhutan

Target Group: DHMS, DDM, DGM, DoES, NLCS, Local Governments and communities in the Project Site

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
[Overall Goal] Nationwide disaster resilient society against natural disasters such as GLOF and rainstorm flood for Climate Change Adaptation is realized in Bhutan.	a. GLOF/rainstorm flood forecasting and early warning is properly disseminated based on accumulation of hydro-met data to relevant agencies at central and local level as well as outside of pilot river basin. b. Evacuation drills are conducted at least one community outside of pilot river basin with EWS.	a. 12th FYP b. DHMS/DDM report	
[Project Purpose] Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced.	a. GLOF/rainstorm flood forecasting and early warning is in place in accordance with developed Standard Operation Procedure (SOP). b. Early warning and evacuation drills in the pilot basins are regularly conducted by use of developed EWS (at least once in a year).	a. 11th FYP Mid-term review b. Project documents	- Necessary budget of DHMS and DDM for maintaining IGEWS is secured. - Government policy of Bhutan on disaster management does not change significantly.
[Outputs] 1: Capacity of related agencies on GLOF/rainstorm flood risk assessment, development planning, disaster prevention, flood forecasting and warning as well as emergency information sharing among relevant agencies is enhanced.	a. Plan of institutional strengthening for mainstreaming disaster risk assessment information into development plans is formulated. b. Equipment and facilities for NWFFWC are installed as scheduled and utilized as planned. c. GLOF/rainstorm flood risk zonation maps are developed. d. Flood and weather forecasting is delivered daily by utilizing improved forecasting system. e. SOP on emergency information sharing is developed.	a. Plan of institutional strengthening b. Project documents c. The zonation maps d. DHMS weather forecasting and warning report e. SOP at central level	- Staff of DHMS, DGM, DoES , NLCS and DDM who participated in trainings of the Project will continuously work in their offices.
2: Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.	a. Equipment and facilities for EWS are installed as scheduled and utilized as planned. b. EWS operation and maintenance manual is developed. c. Trainings for the operation and maintenance of EWS are conducted by use of the manual. (All DHMS staff in charge will join the trainings).	a. Project documents b. The manual c. Training report	
3: Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.	a. Workshops for flood emergency response on warning and evacuation are held with the stakeholders in the target sub-districts. b. Evacuation drill by use of developed EWS is planned and conducted in the pilot basins. c. SOP for GLOF/rainstorm flood in the pilot basins is developed.	a. Workshop report b. Drill evaluation report c. SOP at local level	

Activities	Input		
<Output 1> 1-1. Analyze the existing data accumulation and monitoring/alert system in DHMS /NWFFWC to develop feasible and sustainable integrated platform. 1-2. Set up necessary system and facilities for the integrated platform and train DHMS/NWFFWC staff to operate and maintain the system. 1-3. Review previous study including SATREPS on the potential risk of glacial lakes, and estimate the magnitude of GLOF as well as possible flood considering future climate change in corroboration with DGM and DoES. 1-4. Facilitate the discussion in enhancing coordination between GLOF/rainstorm flood risk assessment sector and development sector. 1-5. Prepare and improve GLOF/rainstorm flood risk zonation to be utilized for activity 3-2 through the training to NWFFWC, DGM, DoES, and NLCS staff. 1-6. Foster the sense of land use management among related agencies through workshops etc. 1-7. Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans. 1-8. Improve flood and weather forecasting system by use of accumulated hydro-meteorological data as well as numerical weather prediction data (GPV: Grid Point Value). 1-9. Develop SOP on emergency information sharing through discussion and workshops with relevant agencies. <Output 2> 2-1. Review existing hydro-meteorological network and planed hydropower plants from the view point of administrative response on GLOF/rainstorm flood. 2-2. Analyze GLOF/rainstorm flood discharge, high-water level, flood arrival time and the other hydrological information to be applied for designing of EWS. 2-3. Design the location and specification of EWS composed of detection system, network, data management protocol and information sharing. 2-4. Install equipment and facilities for the EWS into the both pilot basins and NWFFWC with necessary provisions of spare parts and maintenance tools. 2-5. Prepare EWS operation and maintenance manual to train central and local DHMS staff on its testing, operation and maintenance. <Output 3> 3-1. Review flood emergency response on warning and evacuation in the pilot basins through workshops with participation of DDM, Local Government and Community residents. 3-2. List up the target communities and examine flood warning criteria in the pilot basins in the discussion with Local Government considering the findings derived from the activity 1-5, 2-2. 3-3. Plan and conduct warning and evacuation drills as well as EWS operation drill in the pilot basins. 3-4. Develop SOP for GLOF/rainstorm flood in the pilot basins through evaluation of activity 3-1 to 3-3.	【Japanese side】 (1) Dispatch of Experts Experts(7): - Watershed Disaster Management (Chief Advisor) - Meteorology / Climate Change Adaptation - Hydrology / Glaciology - Flood Hazard Map / GIS - Weather Forecasting - Information Network / EWS - Community Disaster Management (2) Provision of Equipment - Detailed contents will be determined through the implementation of the Project. (3) C/P Training in Japan (4) Local cost shared by Japanese side - If necessity arises	【Bhutanese side】 (1) Counterpart(C/P) personnel - Project Director - Project Manager - Counterparts (2) Office space and facilities for the Project - Office space / facilities - Electricity, Water supply and Internet connection (3) Necessary data - Geometric data - Hydro-Meteorological data - Socio-economic data etc. (4) Necessary arrangement - Land allocation for EWS (5) Local cost shared by Bhutanese side	- Necessary budget for the Project is allocated without any significant delay. - Necessary equipment for the Project is procured without significant delay. [Pre-condition] Political situation of Bhutan is stable.

Annex-5

Project Implementation Schedule of Each Counterpart Agency

	2013				2014												2015												2016								
	1st Phase																								2nd Phase												
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
a. Discussion on IC/R and IC seminar as kickoff.		▨																																			
b. Baseline survey		▨	▨	▨																																	
DHMS DDM DGM DoES NLCS DHS Local Gov.																																					
Output 1 Capacity of DHMS and relevant stakeholders on emergenc response against GLOF/rainstorm flood is enhanced																																					
[1-1] Analysis of Present State of NWFFWC on Existing Hydro-Met Data, Monitoring and Warning		▨	▨	▨	▨																																
DHMS																																					
[1-2] Installation of Necessary Facilities to Develop Integrated Platform and Beginning Its Operation					▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨														
DHMS																																					
[1-3] **Run-off and Flood** Analyses based on Potential GLOF and Climate Change		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																									
DHMS DDM DGM DoES NLCS DHS **(Working Group)**																																					
[1-4] Discussion to Enhance Coordination between GLOF/ Flood Risk Assessment Sector and Development Sector				▨	▨	▨	▨																			▨	▨	▨									
DHMS DDM DGM DoES NLCS DHS																																					
[1-5] **Preparation and Improvement of Hazard Map** through Training for Relevant Agencies					▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨			▨	▨	▨	▨	▨	▨						
DHMS DDM DGM DoES NLCS DHS **(Working Group)**																																					
[1-6] Awareness Raising in Relating Agencies on Land Use Management against Disaster			▨	▨	▨	▨						▨	▨	▨	▨	▨	▨	▨																			
DHMS DDM DGM DoES NLCS DHS Local Gov.																																					
[1-7] Proposal of Institution and Legal System Necessary for Mainstreaming Disaster Risk Assessment into Development Plan																	▨	▨	▨	▨	▨	▨	▨					▨	▨	▨	▨	▨	▨	▨	▨	▨	
DHMS DDM DGM DoES NLCS DHS																																					
[1-8] Improvement of Flood and Weather Forecasting System utilizing Numerical Weather Prediction Data (GPV) by Use of Accumulated Hydro-meteorological Data		▨	▨					▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨			▨	▨	▨	▨	▨	▨	▨	▨	▨	▨		
DHMS																																					
[1-9] Development of SOP on Emergency Information Sharing through Discussion and Workshop with Relevant Agencies																										▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
DHMS DDM DGM DoES NLCS DHS Local Gov.																																					
Output 2 Early Warning System (EWS) for GLOF/rainstorm is developed and maintained in the pilot basins of Mangdechhu and the Chamkharchhu.																																					
[2-1] Analysis of Current Condition and Extraction of Issue on Existing Meteorological and Hydrological Observation Network and Proposed Water Power Plant		▨	▨																																		
DHMS																																					
[2-2] Collecting and Analyzing Fundamental Information for Design of Early Warning System in Basins		▨	▨																																		
DHMS																																					
[2-3] Distribution Plan and Specification of EWS in Pilot Basins			▨	▨	▨	▨																															
DHMS NLCS Local Gov. Community																																					
[2-4] Installation of Equipment and Facilities in Pilot Basins and NWFFWC							▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																			
DHMS																																					
[2-5] Preparation of Manual for EWS Operation and Maintenance and Training for Central and Local DHMS Staff																	▨	▨	▨	▨	▨	▨	▨			▨	▨	▨	▨	▨							
DHMS																																					
Output 3 Emergency response capacity against GLOF/rainstorm flood at central and local level is enhanced in the pilot basins.																																					
[3-1] Holding Workshops to Review Flood Emergency Response on Warning and Evacuation in the Pilot Basins									▨	▨	▨	▨	▨																								
DHMS DDM																																					
[3-2] List Target Communities and Examine Flood Warning Criteria in Pilot Basins															▨	▨	▨	▨	▨	▨	▨	▨	▨														
DHMS DDM Local Gov. Community																																					
[3-3] Plan Warning and Evacuation Drills as well as EWS Operation Drill in the Pilot Basins																						▨	▨				▨	▨		▨	▨						
DHMS DDM Local Gov. Community																																					
[3-4] Develop SOP for GLOF/Rainstorm Flood in Pilot Basins																														▨	▨	▨	▨	▨	▨			
DHMS DDM Local Gov.																																					

Appendix 6

Minutes of Meetings of Progress Report (1)

MINUTES OF MEETINGS
ON
PROGRESS REPORT (1)
FOR
THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

AGREED UPON BETWEEN
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, September 30, 2014

加藤泰彦

Mr. Yasuhiko Kato
Chief Advisor, Expert Team
Japan International Cooperation Agency
(JICA)

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

In response to the request of the Government of Kingdom of Bhutan, the Government of Japan has decided to conduct the technical cooperation concerning the "Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning"(hereinafter referred to as "the Project"). The Japanese side and the Bhutanese side came to an agreement on the Record of Discussion (hereinafter referred to as "R/D") which was signed on 14 May 2013 between Gross National Happiness Commission and Japan International Cooperation Agency (hereinafter referred to as "JICA"). Based on the R/D, JICA dispatched the Expert Team (hereinafter referred to as "the Team") headed by Mr. Yasuhiko Kato from 9 October 2013 for the commencement of the Project.

The Team held a meeting with main counterpart agency, Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and five sub counterpart agencies concerned with the Project and explained the contents of the Progress Report (1) compiling all the progress and achievements of the Project activities from October 2013 to September 2014. The list of the participants is attached as Annex 1.

The Progress Report (1) was accepted by the Bhutanese side in principle. The following are the main points discussed and agreed by the both sides.

1. Progress and Achievements of the Project Activities

   The progress and achievements of the Project activities which were carried out for one year from October 2013 to September 2014 by predominantly the counterpart personnel with support from the Team was agreed upon and accepted by the Bhutanese side.

2. Effectiveness of Working Group Activities

   Many Bhutanese participants expressed the effectiveness of the Project activities through both flood hazard map and mainstreaming disaster risk reduction Working Groups to develop capacity, exchange information and enhance the coordination between the agencies, which were organized by the working level counterpart personnel from all the six counterpart agencies.

3. Issues on Budgetary Restrictions of DDM

   DDM raised the issue on the difficulty of the budget allocation for DDM counterpart personnel to conduct the Project Output 3 (CBDRM) related activities. DHMS replied that the all the counterparts budget required for DDM that are not covered under the JICA TCP have to be met from the co-financing fund received from the Mangdechhu Hydropower Project Authority (MHPA).

4. Division of Roles on Flood Hazard Mapping

   DHS commented that the division of roles of each counterpart agency on flood hazard mapping seems not to be clear. DHMS informed that it will not be the responsibility of the Project to mandate the roles of each counterpart's agency on flood hazard mapping, but to build the technical capacity of counterpart agencies on flood hazard mapping and related subjects. The

DHMS also informed that the joint Project activities conducted by related counterpart agencies through working group could provide inputs to define clear roles in future.

5. Working Groups as a Prototype of Inter-ministerial Task Force

The Team commented that two Working Groups above-mentioned can be a prototype of the Inter-ministerial Task Force to be formulated according to Disaster Management Act 2013. DDM also commented that the formulation of the Inter-ministerial Task Force will be an agenda to be discussed in the Second National Disaster Management Authority, the highest decision-making body to be held on October 2014.

6. Next Meeting

In the first half of 2015 (to be determined), the Second Joint Coordinating Committee (JCC) meeting will be held to discuss the result of the mid-term evaluation of the Project to be conducted jointly by Bhutanese side and a JICA evaluation mission to be dispatched.

Annex-1

Progress Report (1) Meeting Participant List

Bhutanese Side:

Mr. Karma Dupchu	Chief of Hydrology Division, DHMS (Bhutanese Side Project Manager)
Mr. Phuntsho Namgyal	Chief of Planning, Coordination Division, DHMS
Mr. Tayba B Tamang	Off. Chief of Meteorology Division, DHMS
Mr. Tshering Tashi	Snow & Glacier Division, DHMS
Mr. Manila	Senior Hydro-met Technician, DHMS
Mr. Chhador Wangdi	Director, DDM
Mr. Tshwang Norbu	Program Officer, DDM
Mr. Tshering Penjore	Executive Geologist, DGM
Ms. Thinley Choden	Executive Engineer, Flood Engineering Management Division, DoES
Mr. Ugyen M Tenzin	Chief of Urban Planning, Regional Planning Division, DHS

Japanese Side:

Ms. Tomoko Miyata	Project Formulation Advisor, JICA Bhutan Office
Mr. Krishua Subba	Senior Program Officer, JICA Bhutan Office
Mr. Yasuhiko Kato	Chief Advisor/ Basin Disaster Management Planning
Mr. Toru Koike	Vice Chief Advisor/ Flood Forecasting and Warning
Mr. Tetsuro Fukui	ICT/ Early Warning System Planning
Mr. Tomoyuki Wada	Flood Hazard Map/ GIS
Ms. Lolita C. Garcia	CBDRM 1
Ms. Kaoru Sasaoka	CBDRM 2/ Training
Mr. Norio Onjyo	JICA Senior Volunteer to DDM

Appendix　7

Minutes of Meetings of Progress Report (2)

MINUTES OF MEETINGS
ON
THE PROGRESS REPORT (2)
FOR
THE PROJECT FOR CAPACITY DEVELOPMENT OF
GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

AGREED UPON BETWEEN
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, July 13, 2015

加藤泰彦
Mr. Yasuhiko Kato
Chief Advisor, Expert Team
Japan International Cooperation Agency
(JICA)

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

In response to the request of the Government of Kingdom of Bhutan, the Government of Japan has decided to conduct the technical cooperation concerning the "Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning"(hereinafter referred to as "the Project"). The Japanese side and the Bhutanese side came to an agreement on the Record of Discussion (hereinafter referred to as "R/D") which was signed on 14 May 2013 between Gross National Happiness Commission and Japan International Cooperation Agency (hereinafter referred to as "JICA"). Based on the R/D, JICA dispatched the Expert Team (hereinafter referred to as "the Team") headed by Mr. Yasuhiko Kato from 9 October 2013 for the commencement of the Project.

The Progress Report (2) meeting was held on July 10, 2015 with main counterpart agency, Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and five sub counterpart agencies concerned with the Project to discuss the contents of the Progress Report (2) compiling all the progress and achievements of the Project for 10 months from October 2014 to July 2015. The list of the participants is attached as Annex 1.

The Progress Report (2) was accepted by the Bhutanese side in principle. The following are the main points discussed and agreed by the both sides.

1. Activity progress and achievements of the Project

   The activity progress and achievements of the Project which were carried out for 10 months from October 2014 to July 2015 by predominantly the counterpart personnel with support from the Team was agreed upon and accepted by the Bhutanese side.

2. Active involvement of DHMS staff to GTS and EWS installation work

   The team expressed deep gratitude to DHMS for dispatching a total of 16 staff for 2 months (May – June, 2015), at its own expenses, to support the GTS and EWS field installation work conducted by JICA Contractor in Thimphu, Mangdechhu and Chamkharchhu river basins.

3. Additional explanation on the Progress Report (2)

   The Bhutanese side asked about the contents of the Report, 1) evaluation result by the Med-Term Review Mission in February 2015, 2) the criteria of the Alert and Alarm Levels of the EWS and 3) the criteria of the flood risk level of the target communities for CBDRM activities in the Pilot Basins. The Team answered the questions based on the Report and the Bhutanese side understood them.

4. Coordination of different early warning levels between DDM and DHMS

   DDM raised the issue that three early warning levels, Advisory, Watch and Warning are stipulated in the Rules and Regulation of the Disaster Management Act of Bhutan, 2013 and DHMS operates their EWS based on two early warning levels, Alert and Alarm. DDM and DHMS agreed that the coordination of the different levels between DDM and DHMS will be discussed in the Mainstreaming Disaster Reduction Working Group of the Project during the 2nd Phase (October 2015 – August 2016).

5. Issues on the Bumthang Airport on the flood plain

DDM raised the issue that the final GLOF/rainstorm flood hazard map by DHMS/JICA should be presented to the Department of Aviation to raise their awareness on the flood hazard risk of the Bumthang Airport located on the Chamkharchhu flood plain. DHS also raised the issue about the coordination of Bumthang urban development planning by DHS, several flood hazard zonation and the Bumthang Airport runway extension planning by the Department of Aviation. The Team proposed to discuss the issues further in the Mainstreaming Disaster Reduction Working Group of the Project during the 2nd Phase (October 2015 – August 2016) inviting the focal person from the Department of Aviation. The Bhutanese side agreed with the proposal.

6. Future final inspection schedule of GTS and EWS

The Team explained that the final inspection of the installed GTS and EWS by the Team will be conducted in October 2015 because of the delay of the installation work by the JICA Contractor. DHMS agreed to participate the final inspection with the Team. DHMS requested the completion of the installation and the final inspection by the end of October 2015, since DHMS are planning to have the grand opening of the NWFFWC on November 11, 2015. The Team replied to try to complete by then.

7. Working Groups to be developed into Inter-ministerial Task Force

DDM explained that the Flood Hazard Map and Mainstreaming Disaster Risk Reduction Working Groups of the Project will officially be developed into the Inter-Ministerial Task Force stipulated in Disaster Management Act 2013 after the approval of the next National Disaster Management Authority (NDMA) meeting, the national highest decision making body on the disaster management of Bhutan.

8. Involvement of counterpart agencies to the preparation of manuals

DHMS requested the Team that all the counterpart agencies should be involved in the preparation of several manuals, Technical Cooperation Outputs. The Team proposed that they will be able to participate the preparation by joining a series of hands-on trainings based on the draft manual. DHMS agreed with that.

9. Counterpart training participants from district government

DHMS requested the participation to the counterpart training in Japan from district government because of the importance of their involvement to the Project activity. The Team answered to convey this request to JICA Headquarters.

10. Next meeting

The team announced that in March 2016, the Third Joint Coordinating Committee (JCC) meeting will be held to discuss the result of the final evaluation of the Project to be conducted jointly by the Bhutanese side and a JICA Evaluation Mission to be dispatched.

Annex-1

Progress Report (2) Meeting Participant List

Bhutanese Side:

Mr. Karma Tshering	Director, DHMS
Mr. Phuntsho Namgyal	Chief of Planning, Coordination and Research Division, DHMS
Ms. Dema Yangzom	Engineer, Planning, Coordination and Research Division, DHMS
Mr. Tshering Tashi	Snow & Glacier Division, DHMS
Mr. Manila	Senior Hydro-met Technician, DHMS
Mr. Kunzang	Assistant Engineer, Hydrology Division, DHMS
Mr. Tandin	Engineer, Hydrology Division, DHMS
Mr. Bikash Pradhan	Engineer, Hydrology Division, DHMS

Mr. Jigme Chogyal	Program Officer, DDM
Mr. Tshering Penjore	Executive Geologist, DGM
Mr. Tashi Phuntsho	Dy. Executive Engineer, Flood Engineering Management Division, DoES
Ms. Tashi Wangmo	Chief Urban Planner, Survey & GIS Division, DHS
Mr. Sonam	Engineer, Rabten

Japanese Side:

Mr. Krishua Subba	Senior Program Officer, JICA Bhutan Office
Mr. Yasuhiko Kato	Chief Advisor/ Basin Disaster Management Planning
Mr. Kenji Minegishi	ICT/ Early Warning System Planning 2
Mr. Tomoyuki Wada	Flood Hazard Map/ GIS
Ms. Lolita C. Garcia	CBDRM 1
Ms. Kaoru Sasaoka	CBDRM 2/ Training
Mr. Norio Onjyo	Senior Volunteer for DDM

Appendix　8

Annual Seminar Program and Participants List

Annual Seminar 2015
JICA Technical Cooperation Project on Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning
19th June, 2015
Venue: Phuntshopelri, Thimphu, Bhutan

The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

I. OBJECTIVES OF THE PROJECT

The purpose of the DHMS - JICA Technical Cooperation Project (2013-2016) is “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced”.

II. OBJECTIVES OF THE SEMINAR

a. Share and update of project progress and outputs
b. Enhance learning and knowledge exchange, enabling the replication of effective disaster risk reduction measures and adaptation to climate change in other river basins in Bhutan
c. Facilitate information sharing and cooperation through sharing of technical lessons from JICA supported project with other line agencies, international organizations and NGOs

III. ORGANIZATION OF THE SEMINAR

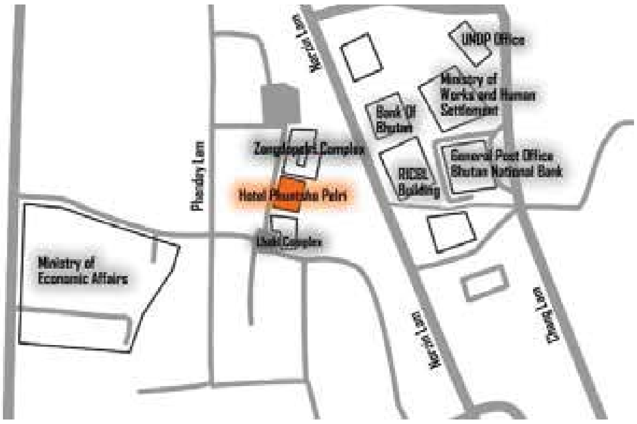
The Department of Hydro-met Services (DHMS), Ministry of Economic Affairs (MoEA) in cooperation and assistance with the JICA Expert Team will organize the Seminar

IV. PARTICIPANTS

Around 50-60 participants will be invited to attend the Seminar from counterpart agencies (Department of Disaster Management (DDM), Department of Geology and Mines (DGM), Department of Engineering Services (DoES), Department of Human Settlement (DHS) under the Ministry of Works and Human Settlement (MoWHS), Gross National Happiness Commission (GNHC), National Land Commission (NEC), Department of Hydropower and Power System (DHPS), Druk Green Power Corporation (DGPC), Mangdchhu Hydropower Project Authority (MHPA), Parliamentarians from Trongsa and Bumthang, local governments (Trongsa and Bumthan), Royal University of Bhutan (RUB), World Bank, UNDP, NGOs (WWF, RSPN, Tarayana), JICA Bhutan Office, etc..

V. DATE, VENUE AND FACILITIES

Date : 19th June, 2015
Duration: One day (09:00～17:00)
Venue : Hotel Phuntshopelri, Thimphu
(Refer map for location)
Dress: Formal
Equipment: Multimedia Projector, etc.
Language: English



VI. PROGRAM

The program of the Seminar is as presented in Attachment 1.

Annual Seminar 2015

JICA Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

19th June, 2015

Final Agenda		
09:00- 09:30	Registration	
09.30 - 10:00	Arrival of Chief Guest	
10:00 - 10:10	Welcome address including objective of the Seminar	Mr. Karma Tsering, Director of DHMS, MoEA
10:10- 10:20	Opening Remarks	Ms. Yumiko Asakuma, Chief Representative of JICA Bhutan Office
10:20- 10:40	Keynote Address by Chief Guest	His Excellency Tengye Lyonpo Norbu Wangchuk, Minister, Ministry of Economic Affairs
10: 40- 11:00	The Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning	Mr. Yasuhiko Kato, Chief Advisor, JICA Expert Team
11:00 – 11:05	Vote of thanks	Mr. Karma Dupchu, Chief/Project Manager, Hydrology Division, DHMS/JICA
11:05- 11:10	Group photo	
11:10- 11:20	Posters Exhibition	
11:20- 11: 40	*Tea/coffee break*	
Session – I, Chair: Mr. Karma Tsering, Director, DHMS		
11:40 – 12:00	Climate change impact on the Glaciers and Glacial lakes in Bhutan	Mr. Tshering Penjore, Executive Engineer of Glaciology Division, DGM, MoEA
12:00 – 12:20	NWFFWC and GLOF Early Warning System in Bhutan	Mr. Karma Dupchu, Chief/Project Manager, JICA Project, DHMS, MoEA
12:20 – 12:40	Study of Potential GLOF area in Bhutan Himalaya using GIS and Remote Sensing	Mr. Tshering, Dean Research & Industrial Linkages, College of Science and Technology
12:40 -13:00	Snow and Glacier Monitoring in Bhutan	Mr. Tshering Wangchuk, SDG, DHMS
13:00 – 14:00	*Lunch*	
Session – II Chair: Hon. Nima, NC Bumthang		
14:00 – 14:20	GLOF/Flood Hazard Mapping in Bumthang, Chamkharchhu basin	Mr. Bikash Pradhan, Engineer of Hydrology Division, DHMS, MoEA (Dr. Tomoyuki Wada, JICA Expert Team)
14:20 – 14:40	Disaster Risk Management Administration in Bhutan	Mr.Chador Wangdi, Director, DDM, MoHCA
14:40 – 15:00	CBDRM Activity in Bumthang, Chamkharchhu basin	Mr. Phuntsho Namgyal, Chief of Planning, Coordination & Research Division, DHMS, MoEA
15:00- 15:20	*Tea/coffee break*	
15:20 – 15:40	Incorporating Disaster Risk Reduction into Bumthang Urban Development Plan	Ms. Tashi Wangmo, Chief Urban Planner of Survey & GIS Division, DHS, MoWHS
15:40- 16:00	Flood Engineering Management in Bhutan	Mr. Tashi Phuntsho, Deputy Executive Engineer of Flood Engineering Management Division, DoES, MoWHS
16:00 – 16:30	Questions and discussion	
16:30- 16:40	Closing remarks by JICA experts	
16:40 -17:00	Closing remarks by Project Director/ Director DHMS	

Annual Seminar 2015
JICA Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning
19th June, 2015
Venue: Phuntshopelri, Thimphu, Bhutan

Participants List

Sl.No.	Name/Designation	Agency	Confirmation
1 2	Hon. Nima, NC, Bumthang Hon. Tharchen, NC, Trongsa	National Council of Bhutan	
3 4	Hon. Dr. Pema Jyamtsho, Opposition Leader, Chhoekhor_Tang, Bumthang	National Assembly of Bhutan	
5	Hon. Mr. Nedup Zangpo, MP, Nubi_Tangsibji, Trongsa		
6	Ms. Yumiko Asakuma, Chief Representative, JICA Bhutan Office	JICA Bhutan Officer	
7	Ms. Tomoko Miyata, Representative		
8	Mr. Krishina, Project Officer, JICA Bhutan		
9 10 11 12 13	Mr. Yasuhiko KATO, Chief Advisor Mr. Tetsuro FUKUI, ITC Dr. Tomoyuki WADA, GIS/Hydrologist Mr. Kenji Minegishi, ICT Mr. Motoyasu Satoh. Meteorologist	JICA Experts, JICA Project	
14	Mr. Chador Wangdi, Director	Department of Disaster Management (DDM),	
15	Mr.Ugyen Wangda, Offtg, DG	Department of Geology and Mines (DGM), MOEA	
16	Mr. Tshering Penjore, Executive Geologist		
17 18 19	Ms. Thinley Chhoden, EE Mr. Pema Choeda, engineer Mr. Tashi Phuntsho, Engineer	Department of Engineering Services (DoES), MOWHS	
20	Ms. Tashi Wangmo, Chief Urban Planner	Department of Human Settlement (DHS), MoWHS	
21	Mr. Tshering Penjore, Survey Officer	National Land Commission	
22 23	Mr. Sonam Dorji, Engineer Ms. Wangmo, Engineer	Department of Hydropower and Power System (DHPS),	
24 25	Ms. Tashi Lhamu, Civil Engineer Ms. Sonam Peldon, Environment Officer	Druk Green Power Corporation (DGPC),	
26	Mr. Tandin Norbu, Civil Engineer	Chief Engineer, Bhutan Electricity Authority,BEA	
27	Mr.Jamyang Chhogyel	Trongsa,Dzongkhag	
28	DYT member	Bumthang Dzongkhag	
29 30	Mr.Tshering ,DRIL Mr.Purna Bdr. Samal, Associate Lecturer	CST, Phuntsholing Royal University of Bhutan	
31	Ms. Dechen Tshering	World Bank,	
32	Mr. Ugyen Dorji	UNDP,	

Annual Seminar 2015
JICA Technical Cooperation Project on Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning
19th June, 2015
Venue: Phuntshopelri, Thimphu, Bhutan

33	Mr.Tashi Dawa, Project Manager	RSPN	
34	Ms. Nagderl Lhamo	WWF	
35	Mr.Jamyang Phuntsho	Tarayana	
36	Mr. Trashi Penjore, Legal Officer	PPD, MOEA	
37	Mr. Karma Tsering, Director, DHMS	DHMS, MOEA	
38	Mr. Karma Dupchu, Chief,	Hydrology Division, DHMS	
39	Mr. Somik Mukherjee, TMO		
40	Mr. Pashupati Sharma, Ex. Engineer		
41	Mr.Pema Wangdi, Asst. Engineer		
42	Mr. Sangay Tenzin, Engineer		
43	Mr. Kush Rai, Asst. Engineer		
44	Mr.Thaba Tamang, Offtg. Chief	Meteorology Division, DHMS	
45	Mr. Kuenzang Sonam, Dy. Chief		
46	Mr. Sonam Rabten, Engineer		
47	Mr. Phuensho Namgyal, Offtg. Chief	Planning Coordination and Research Division (PCRD), DHMS	
48	Mr.Tashi Namgay, Engineer		
49	Mr.Tshewang Rinzin, Engineer		
50	Mr. Tshering Wangchuk, Engineer	Snow and glacier Division (SGD), DHMS	
51	Ms. Jamyang Choden, Engineer		
52	Mr. M.B Subba	Kuensel	
53	Mr. Sonam Ugen	BBS	
		Total	

Annual Seminar 2016
JICA Technical Cooperation Project on Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning
14th June, 2016
Venue: Le Meridien, Thimphu, Bhutan

I. OBJECTIVES OF THE PROJECT

The purpose of the DHMS - JICA Technical Cooperation Project (2013-2016) is “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced”.

II. OBJECTIVES OF THE SEMINAR

a. Share and update of project achievement
b. Enhance learning and knowledge exchange, enabling the replication of effective disaster risk reduction measures and adaptation to climate change in other river basins in Bhutan
c. Facilitate information sharing and cooperation through sharing of technical lessons from JICA supported project with other line agencies, international organizations and NGOs

III. ORGANIZATION OF THE SEMINAR

The Department of Hydro-met Services (DHMS), Ministry of Economic Affairs (MoEA)in cooperation and assistance with the JICA Expert Team will organize the Seminar

IV. PARTICIPANTS

Around 50-60 participants will be invited to attend the Seminar from counterpart agencies (Department of Disaster Management (DDM), Department of Geology and Mines (DGM), Department of Engineering Services (DoES), Department of Human Settlement (DHS) under the Ministry of Works and Human Settlement (MoWHS), National Land Commission (NLC), Gross National Happiness Commission (GNHC), Department of Hydropower and Power System (DHPS), Druk Green Power Corporation (DGPC),Mangdechhu Hydropower Project Authority (MHPA), Parliamentarians from Trongsa and Bumthang, local governments (Trongsa and Bumthang), World Bank, UNDP, NGOs (WWF, RSPN, Tarayana), JICA Bhutan Office, etc..

V. DATE, VENUE AND FACILITIES

Date :	14th June, 2016
Duration:	One day (08:00～17:00)
Venue :	Le Meridien (Chorten Lam,Thimphu)
Dress:	Formal
Equipment:	Multimedia Projector, etc.
Language:	English

VI. PROGRAM

The program of the Seminar is as presented in Attachment 1.

Annual Seminar 2016

JICA Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

14th June, 2016

Venue: Le Meridien, Thimphu, Bhutan

Tentative Final Agenda		
08:00- 08:30	Registration	
08.30 - 09:00	Arrival of Chief Guest	
09:00 - 09:15	Welcome address including objective of the Seminar	Mr. Karma Tsering, Director of DHMS, MoEA
09:15- 09:30	Opening Remarks	Mr. Koji Yamada,Chief Representative of JICA Bhutan Office
09:30- 09:45	Keynote Address by Chief Guest	His Excellency Lyonpo Lekey Dorji. Minister, Ministry of Economic Affairs
09: 45- 10:00	The Achievement of the JICA Technical Cooperation Project	Mr. Yasuhiko Kato, Chief Advisor, JICA Expert Team
10:00- 10:05	Launching of Hydrological Data Book	
10:05 – 10:10	Vote of Thanks	Mr. Karma Dupchu, Chief/Project Manager, Hydrology Division, DHMS/JICA
10:10- 10:20	Group Photo	
10:20 - 10:45	Posters Exhibition	
10:45- 11: 10	*Tea/coffee break*	
Session – I, Chair: ***to be determined***		
11:10 – 11:40	Potential Risk of GLOF in Mangdechhu and Chamkharchhu River Basins	Mr. Karma Tsering, Director of DHMS, MoEA
11:40 – 12:10	Outline of the GLOF/ Rainstorm Flood Early Warning System (EWS) in Mangdechhu and Chamkharchhu Basins in NWFWC, DHMS	Mr. Karma Dupchu, Chief/Project Manager, JICA Project, DHMS, MoEA
12:10 – 12:30	Communication System of GLOF/Rainstorm Flood Early Warning System in Mangdechhu and Chamkharchhu Basins	Mr. Kuenzang, Engineer, Hydrology Division, DHMS, MoEA
12:30 – 12:50	Outline of the Global Telecommunication System (GTS) / Message Switching System (MSS) and HimawariCast in NWFWC, DHMS	Mr. Tayba Buddha Tamang, Senior Meteorologist, Meteorology Division, DHMS, MoEA
12:50 – 14:00	*Lunch*	
Session – II Chair: ***to be determined***		
14:00 -14:20	Flood Forecasting using IFAS and HBV Model for Mochhu and Chamkharchhu sub-basins	Mr.Bikash Pradhan/Mr. Pema Wangdi, Engineer, Hydrology Division, DHMS, MOEA
14:20 – 14:40	Flood Modelling of Dungsamchu, SamdrupJongkhar	Mr. Cheten Dorji/ Mr. Tashi Phuntsho, Deputy Executive Engineer of Flood Engineering Management Division, DoES, MoWHS
14:40 – 15:00	Evacuation Planning and Drill in Bumthang using the EWS in Chamkharchhu River Basin	Mr. Phuntsho Namgyal, Chief of Planning, Coordination & Research Division, DHMS, MoEA
15:00 – 15:20	Development of the Standard Operation Procedure (SOP) for GLOF/ Rainstorm Flood in Mangdechhu and Chamkharchhu River Basins	Mr. Toru Koike, Vice Chief Advisor, JICA Expert Team

Annual Seminar 2016

JICA Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

14th June, 2016

Venue: Le Meridien, Thimphu, Bhutan

15:20 - 15:35	*Tea/coffee break*	
15:35 – 16:00	Course of Action in Establishing Central and District Emergency Operation Centres (EOC)	Mr. Chador Wangdi, Director, DDM, MoHCA
16:00 – 16:20	Mainstreaming Disaster Risk Reduction into Urban Planning in Bhutan	Ms. Tashi Wangmo, Chief Urban Planner, Survey & GIS Division, DHS, MoWHS
16:20 – 16:40	Questions and discussion	
16:40– 16:50	Closing remarks by JICA Experts	
16:50 –17:00	Closing remarks by Project Director/ Director DHMS	

Annual Seminar 2016
JICA Technical Cooperation Project on Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning
14th June, 2016
Venue: Le Meridien, Thimphu, Bhutan

Guest/Participant List:

A. National Participants:

Sl.No.	Name/Designation	Agency	Confirmation
1	Hon'ble Dr. Pema Gyamtsho, Opp. Leader, Chhoekhor-Tang, Bumthang	National Assembly of Bhutan	Confirmed
2	Hon'ble Nedup Zangpo, MP, Nubi Tangsibji, Trongsa	National Assembly of Bhutan	Confirmed
3	Dasho Yeshi Wangdi, Secretary	Ministry of Economic Affairs	Confirmed
4	Mr. Chador Wangdi, Director	Department of Disaster Management), MoHCA.	Confirmed
5	Mr. Mewang Gyeltshen, Director	Department of Renewable Energy (DRE), MoEA	Confirmed
6	Mr. Tenzin, Director	Department of Engineering Services (DES), MoWHS	Confirmed
7	Mr. Dorji Pavo Phuntshok, Project Director	Druk Green Power Corporation (DGPC),	Confirmed
8	Mr. Chencho Tshering, Joint Managing Director (JMD)	Mangdechhu Hydropower Authority (MHPA)	Confirmed
9	Mr. R.K Chaudhary, Director Technical	Mangdechhu HydroPower Authority	Confirmed
10	Mr. Karma Tsering, Director	Department of Hydro-Met Services (DHMS), MOEA	Confirmed
11	Mr. Karma Dendup, Dzongrab	Trongsa Dzongkhag	Confirmed
12	Mr. Yeshi Dorji, Director	National Land Commission	Confirmed
13	Mr. Karma Toeb , Chief	Department of Geology and Mines (DGM), MOEA	Confirmed

Annual Seminar 2016
JICA Technical Cooperation Project on Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning
14th June, 2016
Venue: Le Meridien, Thimphu, Bhutan

14	Mr. Karma Dupchu, Chief	Hydrology Division, Department of Hydro-Met Services, MoEA	Confirmed
15	Ms. Tashi Wangmo, Chief	Department of Human Settlement (DHS), MoWHS	Confirmed
16	Ms. Dago Zangmo, Chief	Department of Engineering Services (DES), MoWHS	Confirmed
17	Mr. Phuetsho Namgyal, Chief	Planning Coordination and Research Division, Department of Hydro-Met Services, MoEA	Confirmed
18	Mr.Tayba BuddhaTamang, Offtg. Chief	Meteorology Division, DHMS, MoEA	Confirmed
19	Mr. Tshering Tashi, Offtg. Chief	Snow and glacier Division (SGD), DHMS, MoEA	Confirmed
20	Mr. Cheten Dorji, Chief Engineer	Department of Engineering Services (DES), MoWHS	Confirmed
21	Mr.	National Environment Commission Secretariat.	
22	Mr. Dr. Om Katel, Lecturer	Royal University of Bhutan	Confirmed
23	Mr. Tenzin Norbu, Chief	National Land Commission	Confirmed
24	Ms. Wangmo, Engineer	Department of Hydropower and Power System (DHPS), MoEA	Confirmed
25	Mr. Yang Dorji,	Department of School Education, MoE	Confirmed
26	Mr. Pratigya Pradhan, Engineer	Druk Green Power Corporation (DGPC)	Confirmed
27	Ms. Tshering Choki, Project Officer	Royal Society for Protection of Nature (RSPN)	Confirmed
28	Ms. Nagderl Lhamo	World Wildlife Fund (WWF)	Confirmed
29	Mr. Sonam Dargay		Confirmed
30	Mr. Sandeepp Rai, General Manager	Bhutan Power Corporation Limited	Confirmed

31	Ms. Kezang Dema, Assistant Engineer	Mangdechu Hydropower Authority (MHPA)	Confirmed
32	Ms. Sunita Neopaney, Assistant Engineer		Confirmed
33	Ms. Alisha Rai, Assistant Engineer		Confirmed
34	Mr. Karma Jamtsho, Assistant Engineer		Confirmed
35	Mr. Sonam Gyeltshen, Assistant Engineer		Confirmed
36	Mr. Namgay, Research Officer		Confirmed
37	Mr. Jamyang Chojay, Disaster Focal Person	Trongsa Dzongkhag	Confirmed
38	Mr. Ugyen Dorji, Human Resource Officer	Bumthang Dzongkhag	Confirmed
39	Mr. Somik Mukherjee, TMO	Hydrology Division, Department of Hydro-Met Services, MoEA	Confirmed
39	Mr. Dhendup Tshering, Principal Engineer		Confirmed
40	Mr. Pashupati Sharma, Ex. Engineer		Confirmed
41	Mr. Pema Wangdi, Asst. Engineer		Confirmed
42	Mr. Sangay Tenzin, Engineer		Confirmed
42	Mr. Kush Rai, Asst. Engineer		Confirmed
43	Mr. Bikash Pradhan, Engineer		Confirmed
44	Mr. Tandin Wangchuk, Engineer		Confirmed
45	Mr. Cheki Dorji, Engineer	Meteorology Division, Department of Hydro-Met Services, MoEA	Confirmed
46	Mr. Pema Syelden, Engineer		Confirmed
47	Mr. Chimmi Wangda, Data Manager		Confirmed
48	Mr. Pema Wangyal, Engineer	Planning Coordination and Research Division, Department of Hydro-Met Services, MoEA	Confirmed
49	Mr. Ugyen Chophel, Statistician		Confirmed
50	Mr. Tashi Phuntsho Engineer	Department of Engineering Services (DES), MoWHS	Confirmed

51	Mr. Sonam Lhendup, Planning Officer	Policy and Planning Division, Ministry of Economic Affairs	Confirmed
52	Mr. Krishna Subba,	JICA Bhutan Office	Confirmed
53	Mr. Tshering Peldon	Kuensel	Confirmed
54	Mr. Ashok Tiwari	BBS	Confirmed

B. International Guests:

1	Mr. Koji YAMADA, Chief Representative	Japan International Cooperation Agency (JICA)	Confirmed
2	Mr. Tomoko MIYATA, In charge of the Project		Confirmed
3 4 5 6	Mr. Yasuhiko KATO, Chief Advisor Mr. Junya Yamaguchi, Chief Adviser of the TCP Mr. Torus KOIKE, Vice Chief Advisor Mr. Kenji MINEGISHI, ICT	JICA Experts, JICA Project	Confirmed
6	Mr. Nimah Challier Smith, Dy. Resident Representative	United Nations Development Programme (UNDP)	Confirmed
7	Dr. Nima WANGCHUK	WHO Country Office for Bhutan	Confirmed

C. Supporting Staff

1	Mr. Ajay Pradhan, Data Assistant	Hydrology Division, DHMS, MoEA	
2	Mr. Manila, Sr. Technician		
3	Ms. Thinley Gyem, Adm. Assistant		
4	Ms. Pasang Gem, Data Assistant		

Appendix　9

Program of Debrief Session on C/P Trainings in Japan

The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

Debrief Session on C/P Trainings in Japan

I. Objectives of the Project

The purpose of the DHMS - JICA Technical Cooperation Project (2013-2016) is “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced”.

II. Objectives of the Session

DHMS holds the Session for all the trainees who participated in the counterpart trainings in Japan to present their training outline in order to share the knowledge and experience with other counterpart personnel and related officials.

III. Organization of the Session

DHMS organizes the Session in cooperation and assistance with the JICA Expert Team.

IV. Participants

Around 25 participants will attend the Session from DHMS, DDM, DGM, DoES, NLCS, DHS, relevant agencies, JICA Bhutan Office and JICA Expert Team

V. Date, Venue and Facilities

Date :	17th April, 2015
Duration:	Half day (9:30～13:00)
Venue :	Energy Conference Hall, MoEA
Dress:	Comfortable
Equipments:	Multimedia Projector, etc.
Language:	English

VI. PROGRAM

The program of the Session is as presented in Attachment 1.

Attachment 1

Department of Hydro-met Services (DHMS),
Ministry of Economic Affairs

Japan International Cooperation Agency (JICA)

JICA Expert Team for Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

Debrief Session on C/P Trainings in Japan

- Thimphu, 17 April, 2015-

Program:

Time	Theme (Name of training course)	Presenter (Training course participants)
9:00 ~ 9:30	Registration	
9:30 ~ 9:40	Opening remarks	Mr. Karma Tsering Director of DHMS, MoEA
9:40 ~ 9:50	Objective of the Session	Mr. Yasuhiko Kato Chief Advisor, JICA Expert Team
9:50 ~ 10:20	Capacity development for flood risk management with IFAS (Jul. 6 – Aug. 2, 2014)	Mr. Karma Dupchu, DHMS and/or Mr. Phuntsho Namgyal, DHMS and/or Mr. Pema Cheda, DoES
10:20 ~ 10:50	Strategy for resilient societies to natural disasters (Jan. 12 – Mar. 7, 2015)	Mr. Tshewang Norbu, DDM and/or Mr. Ugyen M Tenzin, DHS
10:50 ~ 11:00	Coffee Break	
11:00 ~ 11:30	Utilization technology on meteorological satellite data (SATAID) (Oct. 29 – Nov. 8, 2014)	Mr. Kinzang Sonam, DHMS and/or Mr. Sonam Tashi, DHMS and/or Mr. Tshering Peljor, DHMS
11:30 ~ 12:00	Comprehensive disaster risk management administration (Jan. 5 – Feb. 21, 2015)	Ms. Pelden Zangmo, DDM
12:00 ~ 12:30	Reinforcement of meteorological services (Sep. 10 – Dec. 8, 2014)	Mr. Karma Tshewang, DHMS
12:30 ~ 12:55	Free discussion	
12:55 ~ 13:00	Closing remarks	Mr. Karma Tsering Director of DHMS, MoEA
13:00	Lunch	

Note:

1) Please note that this is the presentation of the outline of the training course and **NOT the presentation of the Action Plan** you prepared in the course of the training.

2) Each group (theme) will make presentation using "ONE" PowerPoint material jointly prepared. The number of presenter is free in each group (theme).

The Project for Capacity Development of
GLOF and Rainstorm Flood Forecasting and Early Warning

The 2nd Debrief Session on the Counterpart Training Courses in Japan

I. Objectives of the Project

The purpose of the DHMS - JICA Technical Cooperation Project (2013-2016) is “Capacity of DHMS and relevant stakeholders on emergency response against GLOF/rainstorm flood is enhanced”.

II. Objectives of the Session

DHMS holds the Session for all the trainees who participated in the counterpart training courses in Japan to present their training outline in order to share their knowledge and experience with other counterpart personnel and related officials.

III. Organization of the Session

DHMS organizes the Session in cooperation and assistance with the JICA Expert Team.

IV. Participants

Around 25 participants will attend the Session from DHMS, DDM, DGM, DoES, NLCS, DHS, relevant agencies, JICA Bhutan Office and JICA Expert Team

V. Date, Venue and Facilities

Date :	27 July, 2016
Duration:	Half day (9:30～13:00)
Venue :	Energy Conference Hall, MoEA
Dress:	Comfortable
Equipments:	Multimedia Projector, etc.
Language:	English

VI. PROGRAM

The program of the Session is as presented in Attachment 1.

Attachment 1

Department of Hydro-met Services (DHMS), Ministry of Economic Affairs

Japan International Cooperation Agency (JICA)

JICA Expert Team for Technical Cooperation Project on Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning

The 2nd Debrief Session on the Counterpart Training Courses in Japan

- Thimphu, 27 July, 2016-

Program:

Time	**Theme (Name of training course)**	**Presenter (Training course participants)**
9:00 ~ 9:30	Registration	
9:30 ~ 9:40	Opening remarks	Mr. Karma Tsering Director of DHMS, MoEA
9:40 ~ 9:50	Objective of the Session	Mr. Yasuhiko Kato Chief Advisor, JICA Expert Team
9:50 ~ 10:20	Technology on river management, EWS, weather observation and local government (May 10 – 21, 2015)	Mr. Tenzin, Director of DoES Mr. Karma Dupchu, DHMS Mr. Phuntsho Namgyal, DHMS Mr. Pashupati Sharma, DHMS Mr. Bikash Pradhan, DHMS Mr. Tshering Penjor, DGM
10:20 ~ 10:50	Capacity development for flood risk management with IFAS (July 6 – Aug. 2, 2015)	Mr. Pema Wangdi, DHMS
10:50 ~ 11:00	Coffee Break	
11:00 ~ 11:30	Strategy for resilient societies to natural disasters (Jan.11 - Feb. 26, 2016)	Mr. Yeshi Namgyal, DDM Ms. Tashi Wangmo, DHS
11:30 ~ 12:00	Administration on river management, EWS, weather observation and local government (Jan.17 – 28, 2016)	Mr. Kuenzang, DHMS Mr. Tandin Wangchuk, DHMS Mr. Lungten Thinleym, DoES Mr. Boby Pradhan, NLCS Mr. Tashi Penjor, DHS Mr. Jamyang Chogyal, DDMO, Trongsa
12:00 ~ 12:30	Comprehensive disaster risk management administration (Jan. 11 – Feb. 27, 2016)	Mr. Tshewang Rigzin, DHMS Mr. Yang Dorji, DoSE
12:30 ~ 12:55	Free discussion	
12:55 ~ 13:00	Closing remarks	Mr. Karma Tsering Director of DHMS, MoEA
13:00	Lunch	

Note:

1) Please note that this is the presentation on **what you learn and see in Japan** and **NOT the presentation of the Action Plan** you prepared in the course of the training.

2) Each group (theme) will make presentation using “ONE” PowerPoint material jointly prepared. The number of presenter is free in each group (theme).

Appendix　10

Minutes of Meetings of Flood Hazard Map Working Group Workshops

JICA Expert Team
February 12, 2014

Memorandum

1st Meeting of FHM Working Group

Purpose of the W/G

The purpose and function of the W/G was explained by Mr. Karma Dupchu, PM and JICA experts.

- Mr. Koike presented the institutions and regulations on FHM in Japan.
- The FHMs in Japan are prepared by a strong initiative of Ministry of Land, Infrastructure, Transportation and Truism (MLIT). In Bhutan, however, the necessary functions such as river monitoring, flood protection works, geomorphological survey, Land use, etc… are dispersed to the individual agencies. Therefore preparation of FHM is inter-ministerial issues.
- W/G members remarked that the Inter-Ministerial Task Force will be formulated according to the National Disaster Prevention Act 2013. The guideline and manual developed by the W/G shall be referred by Inter-Ministerial T/F when launched.

Concept of Flood Zonation Mapping

The basic flow and overall schedule for flood hazard zonation mapping were presented by Dr. Wada. In the project, IFAS and iRIC (or HEC-RAS) will be employed for runoff modeling and flood analysis respectively. In addition,the following technical issues were discussed:

- Difference between ArcGIS and Quantum GIS
- Functions of IFAS program and parameters
- Risk assessment in the training

Activities and Meeting Ahead

- It was suggested by W/G members that it is not necessary to issue official letters to hold the W/G meetings. The project directly informs to W/G members by email. The date of meeting should be announced before 1 week so that W/G member could arrange the schedule.
- Dr. Wada demonstrates GPS survey in Thimphu in February. The expected date will be informed to the participants.

1st Meeting at DHMS

- The FHM related information should be shared within the W/G. Therefore each agency were requested to present their own field in the next meeting. The detail will be requested from JICA experts.

JICA Expert Team
April 30, 2014

Memorandum

2nd Meeting of FHM Working Group

Today's topics

1. Presentation from Mr. Tashi Phuntsho about objective and mandates of Flood Engineering Management Division, Department of Engineering Services
2. Short report about GPS/Total Station survey in Bumthang and Bjizam

   Place and period: Bumthang 3/25-29, Bjizam 3/30
3. Schedule of FHM training (in end of June)
   - Steps of basic runoff and flood analysis training
     - **i.** Data preparing ---- 2 days
     - **ii.** Runoff analysis ---- 1 day
       (runoff analysis by IFAS, calculated discharge will be utilized on flood analysis)
     - **iii.** Flood analysis ---- 2 days
       (flood analysis by HEC-RAS and iRIC)
       1D model to estimate water stage of river channel / 2D model to detect inundation area and water level
     - **iv.** Plotting calculated flood area on settlement data ---- 1 day

Comments and discussion by the participants

- FEMD and DHMS has similar plan to build runoff model. However, the objective is different (FEMD: for structural countermeasure, DHMS: for extensive purpose such as flood warning)
- Balance of bank protection and environmental conservation is important. As an example in japan, three side protections (river banks and bed) is utilized as one of effective structural countermeasure, but this technique causes severe impacts on living environment of aquatic organism and fishes. Countermeasure selection taking into account environmental effect is necessary.
- Embankment in the Bumthang town is bored for easy river access. Awareness activity for local people is important to improve their mind for disaster management.
- River bank erosion occurs at some part of farming land beside the Chamkharchhu.
- Some road side gabions are also damaged along the Chamkharchhu. Countermeasure is needed to protect them from river erosion.

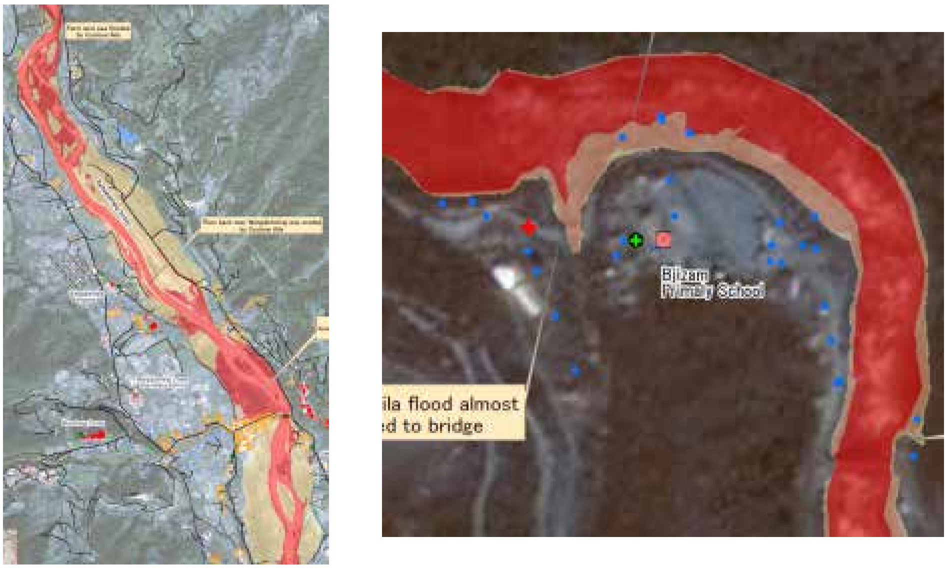
JICA Expert Team
Oct 7, 2014

Memorandum

3rd Meeting of FHM Working Group

Today's topics

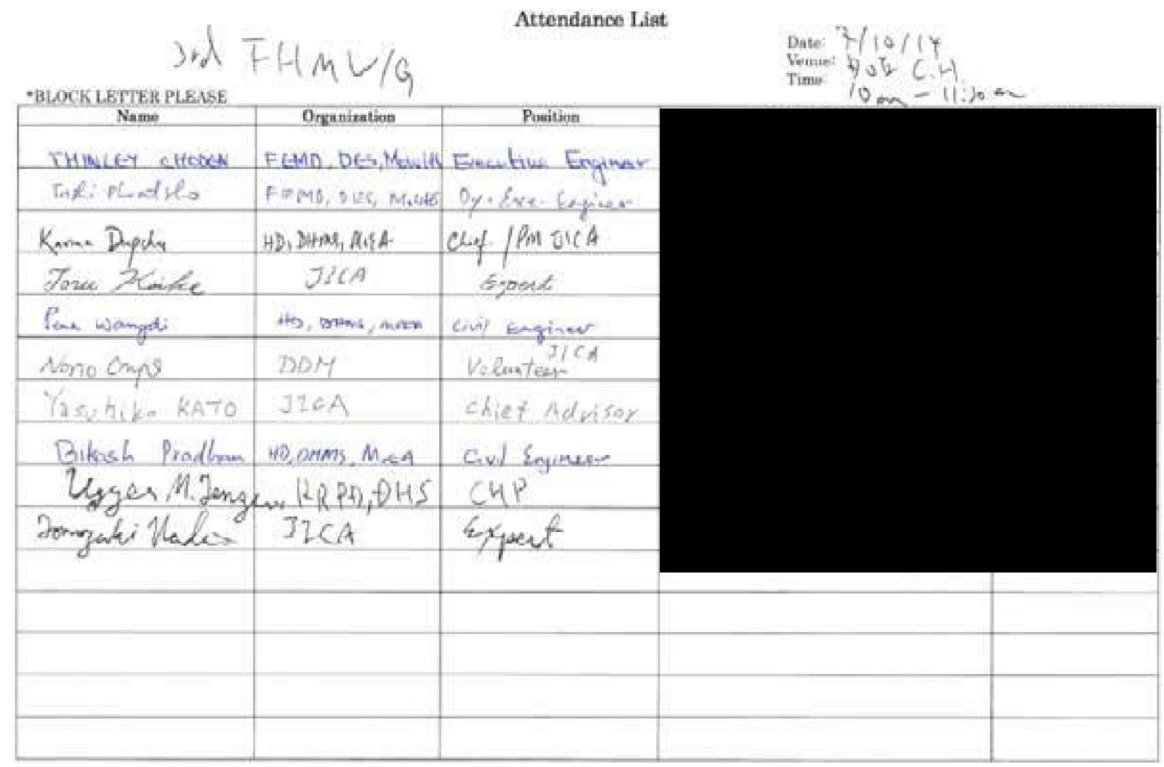
Discussion about draft flood hazard maps in Chamkharchhu and Mangdechhu river basin



Flood hazard map (GLOF scenario) in Bumthang valley (left) and Bjizam (right)

Comments and discussion by the participants

- The draft flood hazard maps prepared by hydrological methods are introduced to FHM W/G members. At the beginning, overall analysis in Chamkharchhu basin (from glacial lake to Bumthang valley) and Mangdechhu basin (from glacial lake to the hydropower plant site) were shown to the members. Subsequently, the detailed hazard maps in Bumthang, Choekhor Toe, Kagthang and Bjizam villages were explained.
- DHS is preparing the development plan in Bumthang valley based on hazard maps prepared by DHS and DGM. The development plan contains relocation and development protection in the risk area. However, there are small risk area difference between the DHS/DGM flood hazard maps and ours. We need to discuss which map we should use for the plan.
- Past flood records must be shown in the flood hazard maps. Such kind of information is important for local people and judging the reasonability of the analysis.
- After finalizing the flood hazard maps, it might be better to explain the maps to the Directors before the maps will be published.



Attendance List

3rd FHMWG

Date: 7/10/14
Venue: DoHS C.H
Time: 10 am – 11:30 am

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
THINLEY CHODEN	FEMD, DES, MoWHS	Executive Engineer	[redacted]	[redacted]
Tashi Phuntsho	FEMD, DES, MoWHS	Dy. Exe. Engineer	[redacted]	[redacted]
Karma Dupchu	HD, DHMS, MoEA	Chief / PM JICA	[redacted]	[redacted]
Toru Koike	JICA	Expert	[redacted]	[redacted]
Pema Wangdi	HD, DHMS, MoEA	Civil Engineer	[redacted]	[redacted]
Nono Ongs	DDM	Volunteer JICA	[redacted]	[redacted]
Yasuhiko KATO	JICA	Chief Advisor	[redacted]	[redacted]
Bikash Pradhan	HD, DHMS, MoEA	Civil Engineer	[redacted]	[redacted]
Ugyen M. Jamyen	RRPD, DHS	CHP	[redacted]	[redacted]
[illegible]	JICA	Expert	[redacted]	[redacted]

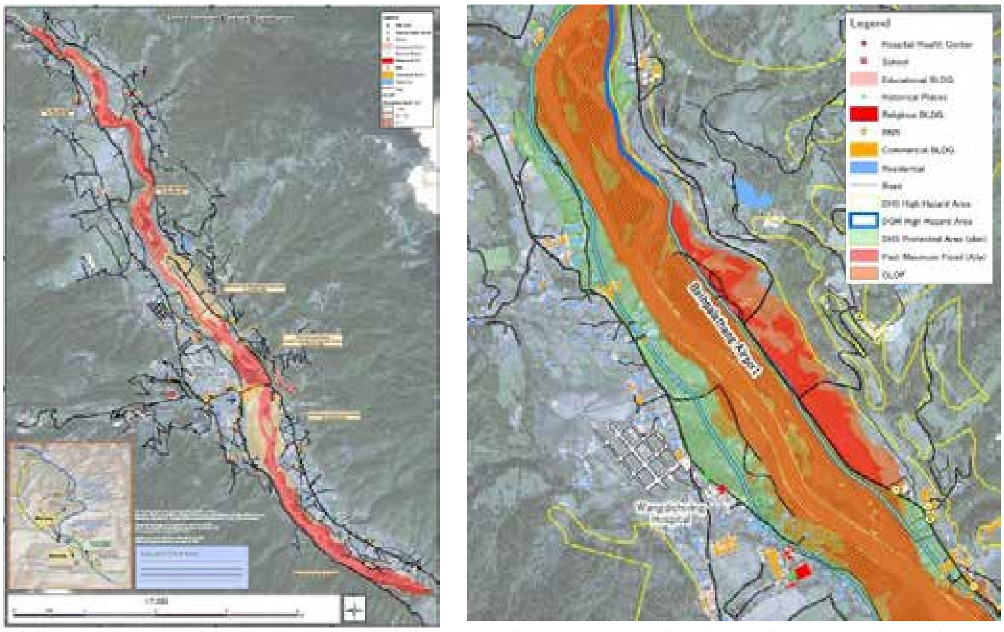
JICA Expert Team
Feb 25, 2015

Memorandum

4th Meeting of FHM Working Group

Today's topics

Finalization of flood hazard maps in Chamkharchhu and Mangdechhu river basin



Flood hazard map (GLOF scenario) in Bumthang valley (left) and comparison between the simulated flood area and the protected area of DHS development plan (right)

Comments and discussion by the participants

◆ The past maximum rainstorm flood (Cyclone Aila) and GLOF scenarios are selected for flood hazard maps in the project area.

(Peak discharge)	100yrs return period < past max. (Aila) < GLOF
(Possibility)	100yrs return period > past max. (Aila) > GLOF?

◆ We can use those flood hazard maps as basic information when the Government of Bhutan makes development plans or conducts disaster risk management activities.

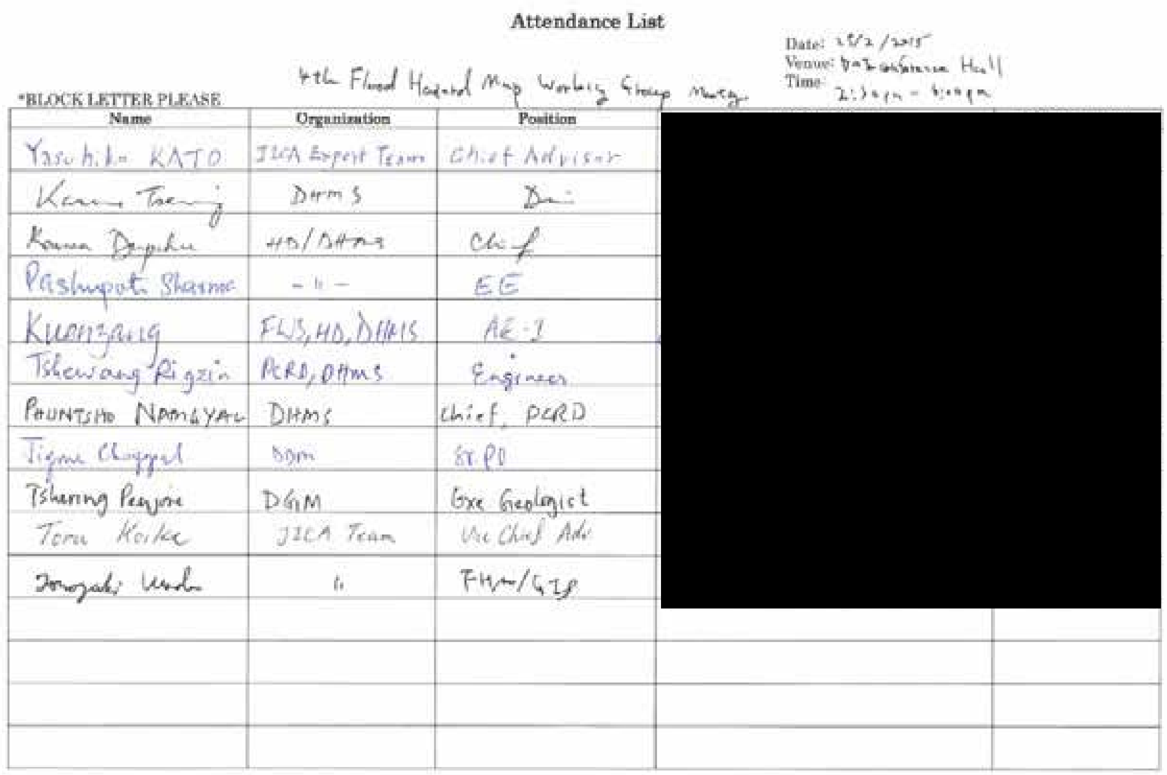
◆ The government should discuss which scenario is suitable for development plan making, considering balance of countermeasure costs, preservation property and possibility of the flood.

◆ If the detail of the preservation property in the risk area could be evaluated, the information must be helpful for the government decision making.

◆ There is a difference between the simulated flood area and the protected area of DHS development plan near Bathpalathang airport. Discussion is necessary to solve this issue.

◆ The flood hazard maps should be introduced to Dzongkhag officers.

◆ Japanese standard of flood risk classification (-0.5m: underfloor flooding, 0.5-3.0m: over-floor flooding, 3.0m-: upstairs or higher floor flooding) is also suitable in Bhutan.



Attendance List

4th Flood Hazard Map Working Group Meeting

Date: 25/2/2015
Venue: [illegible] Conference Hall
Time: 2:30pm - 5:00pm

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
Yasuhiko KATO	JICA Expert Team	Chief Advisor	[redacted]	[redacted]
Karma Tsering	DHMS	Dir	[redacted]	[redacted]
Karma Dupchu	HD/DHMS	Chief	[redacted]	[redacted]
Pashupati Sharma	- " -	EE	[redacted]	[redacted]
Kuenzang	FWS, HD, DHMS	AE-I	[redacted]	[redacted]
Tshewang Rigzin	PCRD, DHMS	Engineer	[redacted]	[redacted]
PHUNTSHO NAMGYAL	DHMS	Chief, PCRD	[redacted]	[redacted]
Jigme Chogyel	DDM	Sr PO	[redacted]	[redacted]
Tshering Penjore	DGM	Exe Geologist	[redacted]	[redacted]
Toru Koike	JICA Team	Vic Chief Adv	[redacted]	[redacted]
Tomoyuki Ueda	"	FHM/GIS	[redacted]	[redacted]

JICA Expert Team
March, 2016

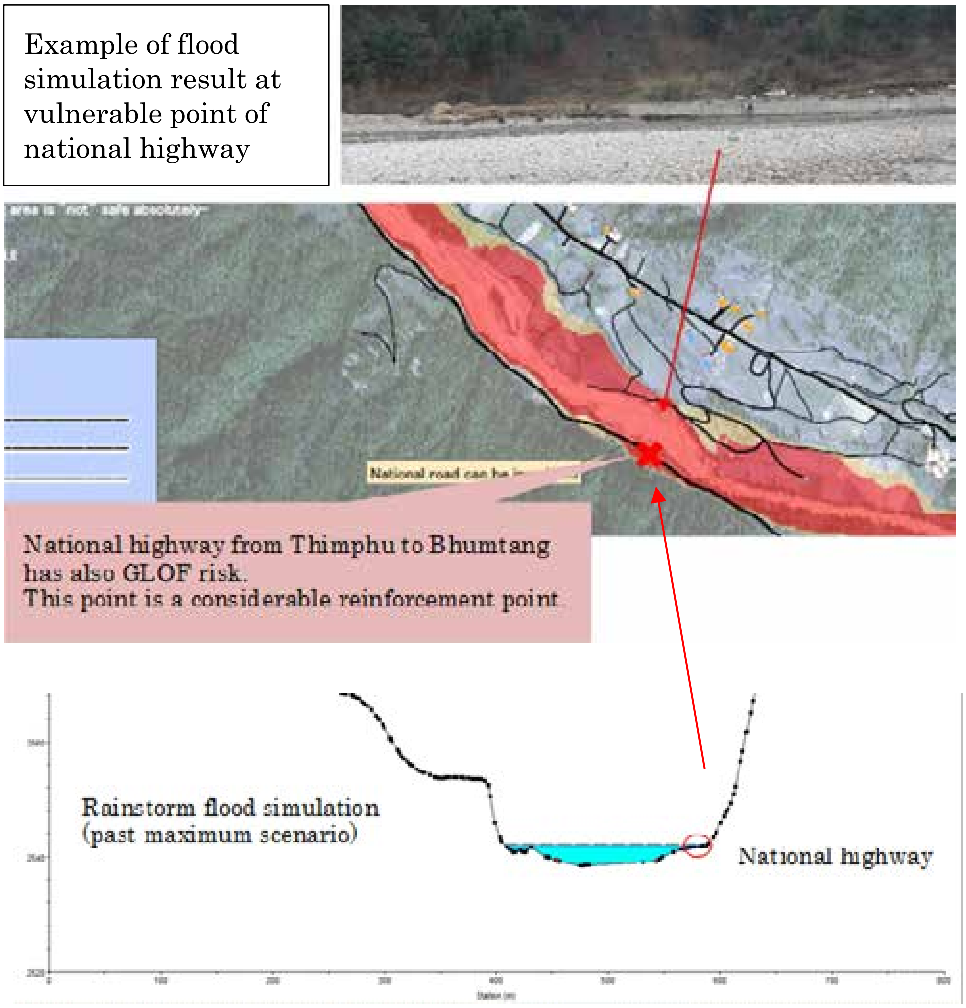
Memorandum

5th Meeting of FHM Working Group

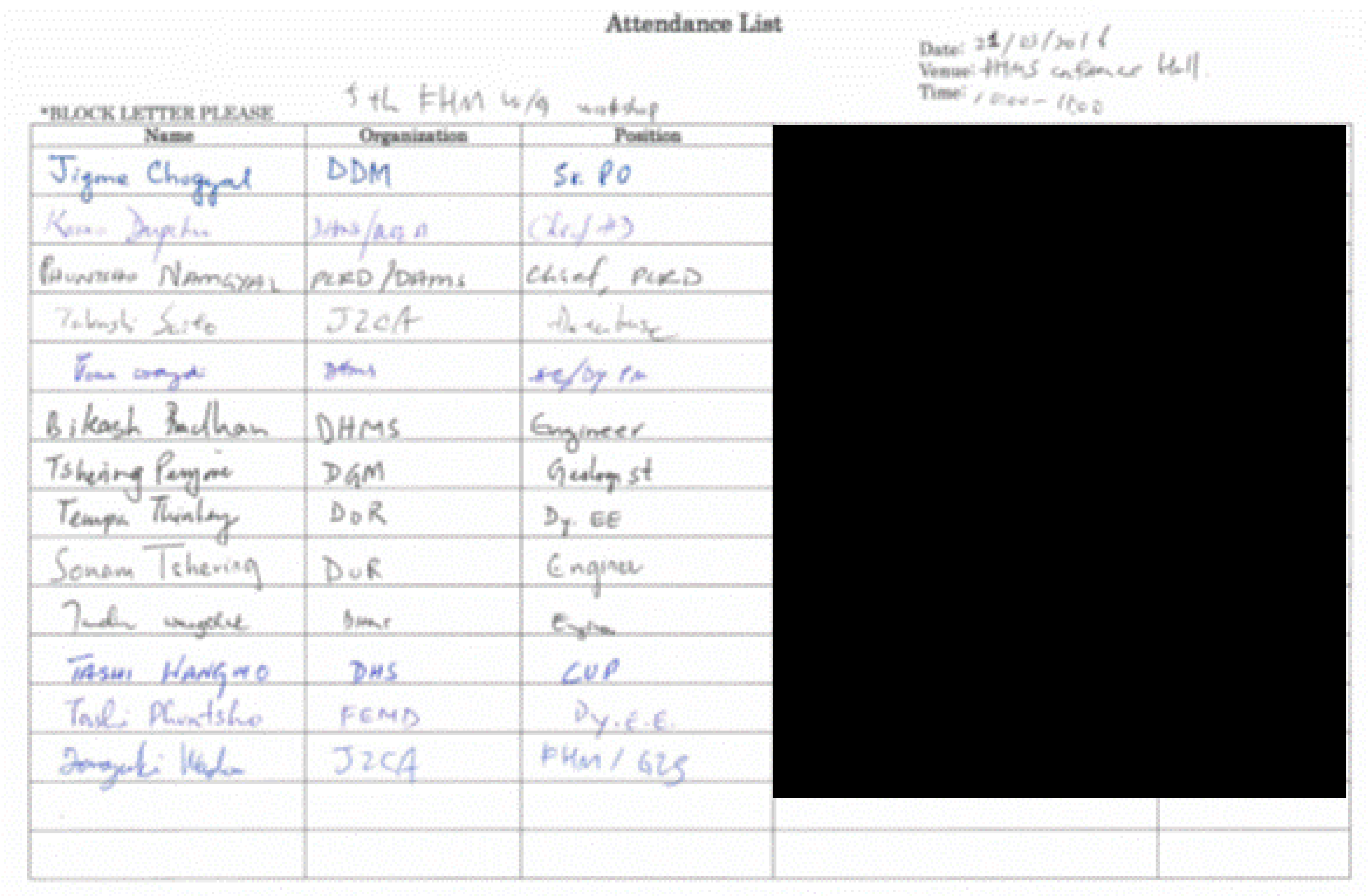
Today's Topics

1. Flood Hazard Map (FHM) preparation manual
   - The draft FHM preparation manual was shared among the members. The manual would be updated considering comments from the members.
   - Roles of relevant agencies and flow of FHM preparation was discussed.
2. Schedule of the next runoff/flood analysis training and target areas
3. Application of the FHM for other sector activities (invite new member from road sector, Department of Road, as an end user of flood hazard maps)
   - FHM is helpful information for structure design works. Thus, Department of Road, MoWHS, was invited as a new member of W/G.

- Examples of flood risk evaluation by flood analysis are introduced to the members and discussed.


Example of flood simulation result at vulnerable point of national highway

National highway from Thimphu to Bhumtang has also GLOF risk.
This point is a considerable reinforcement point



Attendance List

Date: 21/03/2016
Venue: DHMS conference Hall
Time: 1000 – 1600

5th FHM W/G workshop

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Name	Organization	Position	[redacted]	[redacted]
Jigme Choggyal	DDM	Sr. PO	[redacted]	[redacted]
Karma Dupchu	DHMS/AGD	(Chief/HD)	[redacted]	[redacted]
Phuntsho Namgyal	PLRD /DHMS	Chief, PLRD	[redacted]	[redacted]
Takeshi Saito	JICA	Director	[redacted]	[redacted]
[illegible]	DHMS	[illegible]	[redacted]	[redacted]
Bikash Pradhan	DHMS	Engineer	[redacted]	[redacted]
Tshering Penjore	DGM	Geologist	[redacted]	[redacted]
Tempa Thinley	DoR	Dy. EE	[redacted]	[redacted]
Sonam Tshering	DoR	Engineer	[redacted]	[redacted]
Tandin Wangchuk	DHMS	Engineer	[redacted]	[redacted]
TASHI WANGMO	DHS	CUP	[redacted]	[redacted]
Tashi Phuntsho	FEMD	Dy. E.E.	[redacted]	[redacted]
Tomoyuki Wada	JICA	FHM / GIS	[redacted]	[redacted]

Appendix 11

Minutes of Meetings of Mainstreaming Disaster Risk Reduction Working Group Workshops

JICA Expert Team
February 27, 2014

Memorandum

1st Meeting of MDRR Working Group

General

The 1st meeting of Mainstreaming of Disaster Risk Reduction (MDRR) Working Group (W/G) was held on Feb. 26 (10:00-11:30) at DHMS conference hall. The participants list is as attached. The followings are the main point discussed.

Purpose of the W/G

The purpose and function of the MDRR W/G was explained by Mr. Karma Dupchu, PM DHMS and Mr. Kato, JICA expert.

Mainstreaming of Disaster Risk Reduction

- Mr. Kato introduced the examples of the documents on MDRR (Sendai Statement Japan 2012 & UNESCO's Children's Charter).
- Mr. Jigme, DDM made a presentation on "What is Mainstreaming?".

1st Meeting at DHMS

Present Status of Disaster Management Act 2013

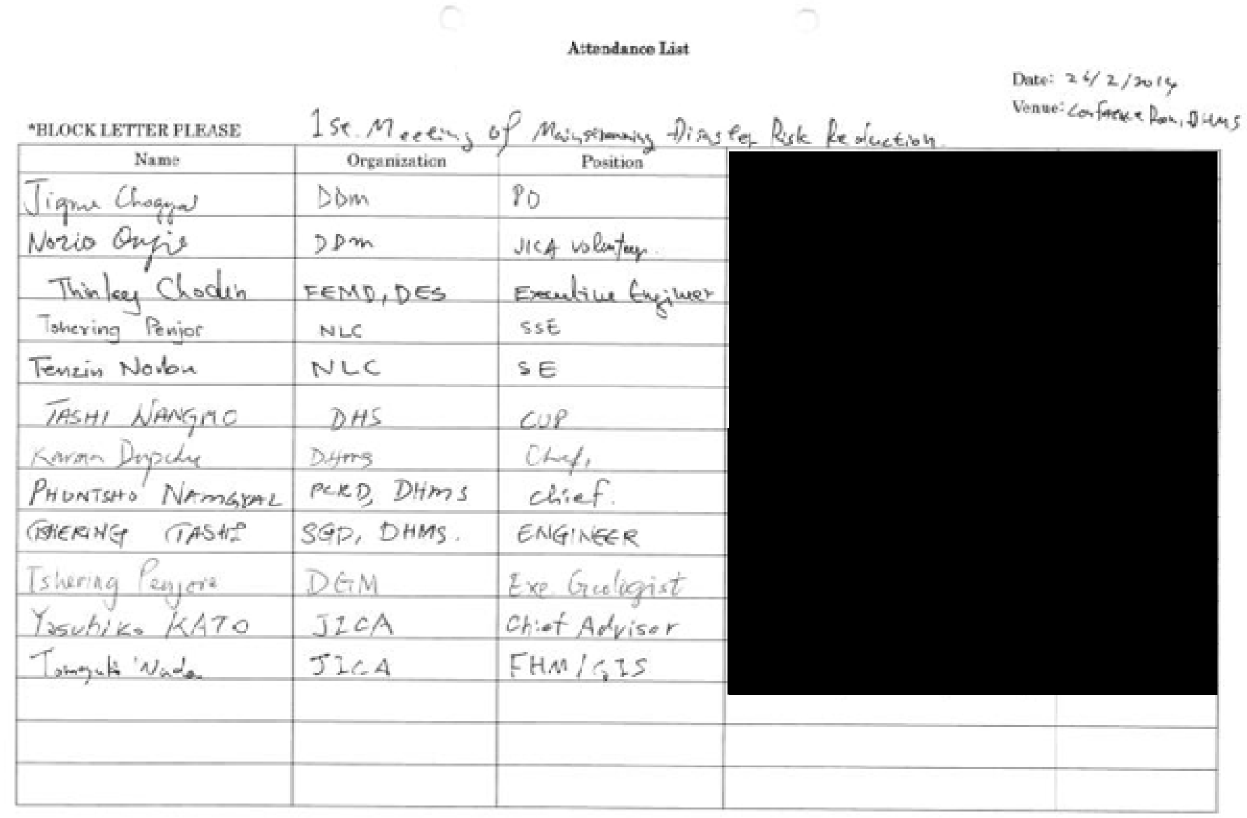
- Mr. Jigme, DDM also made a presentation on the present status of the DM Act 2013. Important points are:
  - Formation of National Disaster Management Authority (NDMA) in March 2014
  - Endorsement of DM Rules and Regulation by NDMA in March 2014
  - Sensitization on the DM Act, 2013 and DM Rules and Regulation to Dzongkhags & Ministries begin by April 2014
  - Complete the formulation of DM and Contingency planning guidelines by the end of March 2014

Baseline Survey Result

- Mr. Kato briefed the result of the baseline survey conducted by the questionnaire & interview surveys to 6 W/G agencies. Mr. Kato expressed the gratitude to the W/G members on the kind cooperation to the survey.
- The baseline survey result will be reviewed and updated by the W/G members in the 3rd W/G meeting (workshop) to be held on May 2014.

Activities and Meeting Ahead

- It was suggested by W/G members that it is not necessary to issue official letters to hold the W/G meetings. The project directly informs to W/G members by email.
- The 2nd W/G meeting (workshop) will be held on Mar. 7 (14:30-16:00) to discuss “Land use management against disaster” (Activity 1-6 of the Project). It was decided through discussion that several W/G members will make presentations on this issue in the 2nd W/G meeting to promote mutual understanding as follows:
  - Mr. Tshering Penjor (NLCS): Field land demarcation work with relevant agencies for land use regulation in hazard area (15 min.)
  - Ms. Thinley Choden (DHS): Outline of Bumthang Master Plan (15 min.)
  - Mr. Tshering Penjore (DGM): Hazard zonation map and hazard zone demarcation along Chamkharchhu in Bumthang (15 min.)



Attendance List

Date: 24/2/2014
Venue: Conference Room, DHMS

*BLOCK LETTER PLEASE 1st Meeting of Mainstreaming Disaster Risk Reduction

Name	Organization	Position	[redacted]	[redacted]
Jigme Chogyal	DDM	PO	[redacted]	[redacted]
Norio Oujis	DDM	JICA volunteer.	[redacted]	[redacted]
Thinley Choden	FEMD, DES	Executive Engineer	[redacted]	[redacted]
Tshering Penjor	NLC	SSE	[redacted]	[redacted]
Tenzin Norbu	NLC	SE	[redacted]	[redacted]
TASHI NANGMO	DHS	CUP	[redacted]	[redacted]
Karma Dupchu	DHMS	Chief,	[redacted]	[redacted]
PHUNTSHO NAMGYAL	PCRD, DHMS	chief.	[redacted]	[redacted]
TSHERING TASHI	SGD, DHMS.	ENGINEER	[redacted]	[redacted]
Tshering Penjore	DGM	Exe. Geologist	[redacted]	[redacted]
Yasuhiko KATO	JICA	Chief Advisor	[redacted]	[redacted]
Tomoyuki Wada	JICA	FHM/GIS	[redacted]	[redacted]

JICA Expert Team
March 10, 2014

Memorandum

2nd Meeting of MDRR Working Group

General

The 2nd meeting of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on Mar. 7 (14:30-16:00) at DHMS conference hall. The participants list is as attached. The followings are the main point discussed.

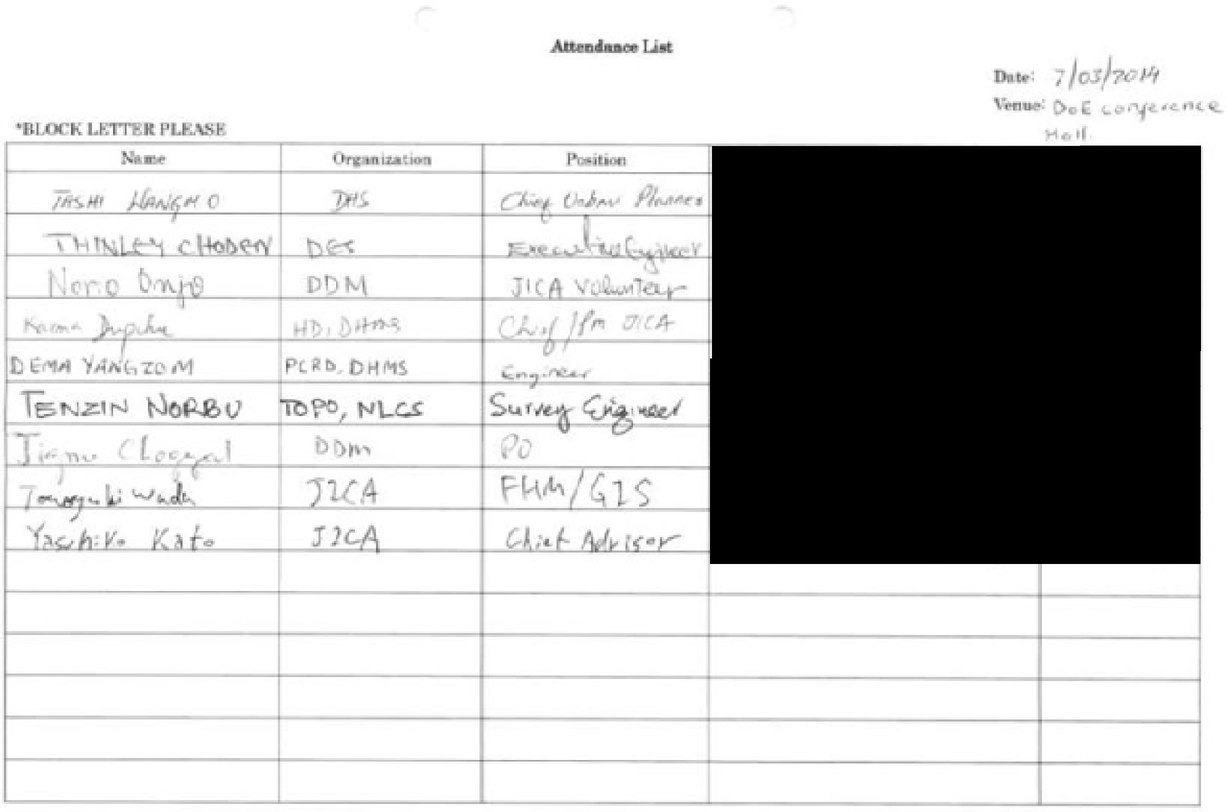
Disaster Related Land Use Management

2nd Meeting at DHMS

- W/G members made the following presentations promote mutual understanding and raise awareness on this issue:
  - Ms. Tashi Wangmo (DHS): Incorporating disaster risk reduction in Bumthang Master Plan preparation
    - The Master Plan formulation was completed in Oct. 2013 and the local (detailed) plan is now under preparation.
    - The Plan was formulated taking into consideration the flood and landslide hazard risk zonation as prerequisite.
  - Mr. Tenzin Norbu (NLCS): Field land demarcation work for allotted land through various processes
    - Local (detailed) area plan formulated by agency will be demarcated and validated by NLCS.
- Free discussion was held based on the presentations as follows:
  - Hazard zonation is not the mandate of DHS in formulating Bumthang Master Plan, however, DHS had to conduct it by outsourcing to Bhutanese local consultant, since DGM was too busy to do it.
  - The local plan of Bumthang Master Plan will be “validated” by NLCS with the cooperation of DHS and Dzongkhag (neither approval nor endorsement).
  - According to DoES, The flood embankment along Chamkharchhu in front of Bumthang airport was constructed by Department of Aviation as attached structure.
  - Harmonization of the following 2 flood hazard zonation in Bumthang will be important:
    - by DHS by geomorphological analysis in Bumthang Master Plan
    - by DHMS/JICA Project by hydrological/ hydraulic analyses to be conducted through FHM Working Group

Activities and Meeting Ahead

- The 3rd W/G meeting (workshop) will be held on May 2014 (date to be announced). The agenda will be as follows:
  - Presentation by Mr. Tshering Penjore (DGM): Hazard zonation map and hazard zone demarcation along Chamkharchhu in Bumthang (15 min.) <postponed from 2nd to 3rd meeting>
  - Review and update of the baseline survey result (already distributed in the 1st meeting) by W/G members



Attendance List

Date: 7/03/2014
Venue: DoE conference Hall.

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
TASHI WANGMO	DHS	Chief Urban Planner	[redacted]	[redacted]
THINLEY CHODEN	DES	Executive Engineer	[redacted]	[redacted]
Norio Onjo	DDM	JICA Volunteer	[redacted]	[redacted]
Karma Dupchu	HD, DHMS	Chief / PM JICA	[redacted]	[redacted]
DEMA YANGZOM	PCRD, DHMS	Engineer	[redacted]	[redacted]
TENZIN NORBU	TOPO, NLCS	Survey Engineer	[redacted]	[redacted]
Jigme Chogyal	DDM	PO	[redacted]	[redacted]
Tomoyuki Wada	JICA	FHM/GIS	[redacted]	[redacted]
Yasuhiko Kato	JICA	Chief Advisor	[redacted]	[redacted]

JICA Expert Team
June 9, 2014

Memorandum

3rd MDRR Working Group Workshop

General

The 3rd workshop of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on June 6, 2014 from 10:00 to 11:45 at DHMS conference hall with the attendance of the Director of DHMS. The participants list is as attached. The followings are the main issue discussed.

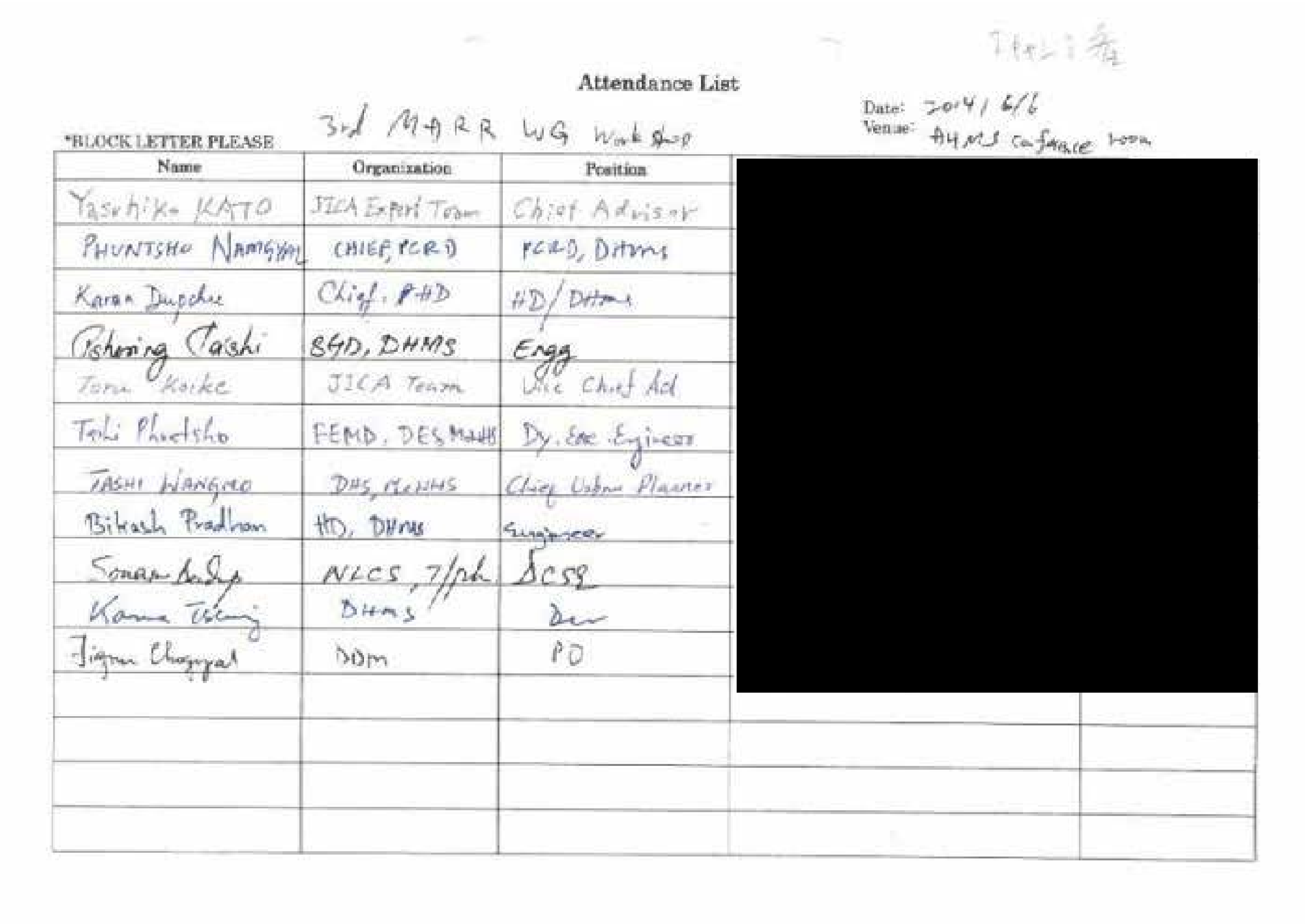
Review and Update of Baseline Survey Result

3rd Meeting at DHMS

- All the participants jointly reviewed and updated the baseline survey result prepared based on the questionnaire and interview surveys to 6 agencies, which was distributed in the 1st W/G workshop on Feb. 26, 2014 as follows:
- Jointly updated baseline survey result will be disseminated to all the participants upon compiled.
- In promoting Bumthang Master Plan, DHS raised the difficulties in the coordination between DHS's flood/landslide hazard zonation and DGM's GLOF hazard zonation.

Activities and Meeting Ahead

- The 4th W/G workshop will be held on October 2014 (date to be announced). The agenda will be as follows:
  - Preparation for the formulation of an action plan on the Bumthang land use planning against disaster by harmonizing the following 3 hazard zonation in Bumthang. The focal person of Bumthang Dzongkhag will be invited to the meeting.
    - DHS's flood and landslide hazard zonation
    - DGM's GLOF hazard zonation
    - JICA's GLOF/flood hazard zonation (to be drafted by Sep. 2014)
  - Presentation by Mr. Tshering Penjore (DGM): Hazard zonation map and hazard zone demarcation along Bumthang valley (15 min.) <postponed from 2nd to 4th meeting>



[illegible]

Attendance List

3rd MARR WG Workshop

Date: 2014/6/6
Venue: DHMS conference room

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
Yasuhiko KATO	JICA Expert Team	Chief Advisor	[redacted]	[redacted]
PHUNTSHO NAMGYAL	CHIEF, PCRD	PCRD, DHMS	[redacted]	[redacted]
Karma Dupchu	Chief, FHD	HD/DHMS	[redacted]	[redacted]
Tshering Tashi	SGD, DHMS	Engg	[redacted]	[redacted]
Toru Koike	JICA Team	Vice Chief Ad	[redacted]	[redacted]
Tashi Phuntsho	FEMD, DES MoWHS	Dy. Exe. Engineer	[redacted]	[redacted]
TASHI WANGMO	DHS, MoWHS	Chief Urban Planner	[redacted]	[redacted]
Bikash Pradhan	HD, DHMS	Engineer	[redacted]	[redacted]
Sonam Dendup	NLCS, T/phu	DCSO	[redacted]	[redacted]
Karma Tsering	DHMS	Dir	[redacted]	[redacted]
Jigme Chogyal	DDM	PD	[redacted]	[redacted]

DHMS &JICA Expert Team
April17, 2015

Memorandum
4thMDRR Working Group Workshop

General

The 4th workshop of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on April10, 2015 from 14:30 to 16:00 at DHMS conference hall. 14 working members from all the counterpart agencies, DHMS, DDM, DGM, DoES, NLCS and DHS including the Director of DHMS attended the workshop. The participants list is as attached as annexure. The main issues discussed are as follows:

Review of GLOF Hazard Map along Bumthang Valley by DGM

- Mr. Tshering Penjore (DGM) presented the process carried out in developing the GLOF hazard map. (postponed from 2nd to 4th workshop)
  - GLOF hazard map was developed by DGM in 2007 based on the topographic survey and soil condition (not based on hydrological/hydraulic analysis).
  - Based on the request from DDM to DGM, DGM carried out the demarcation of hazard map in December 2011. Further, DGM also identified safe evacuation areas and DDM created awareness to people on how to get to the evacuation areas during the times of disaster.

Incorporating Hazard Zonation in the preparation of Bumthang Valley Development Plan by DHS

4thWorkshop at DHMS

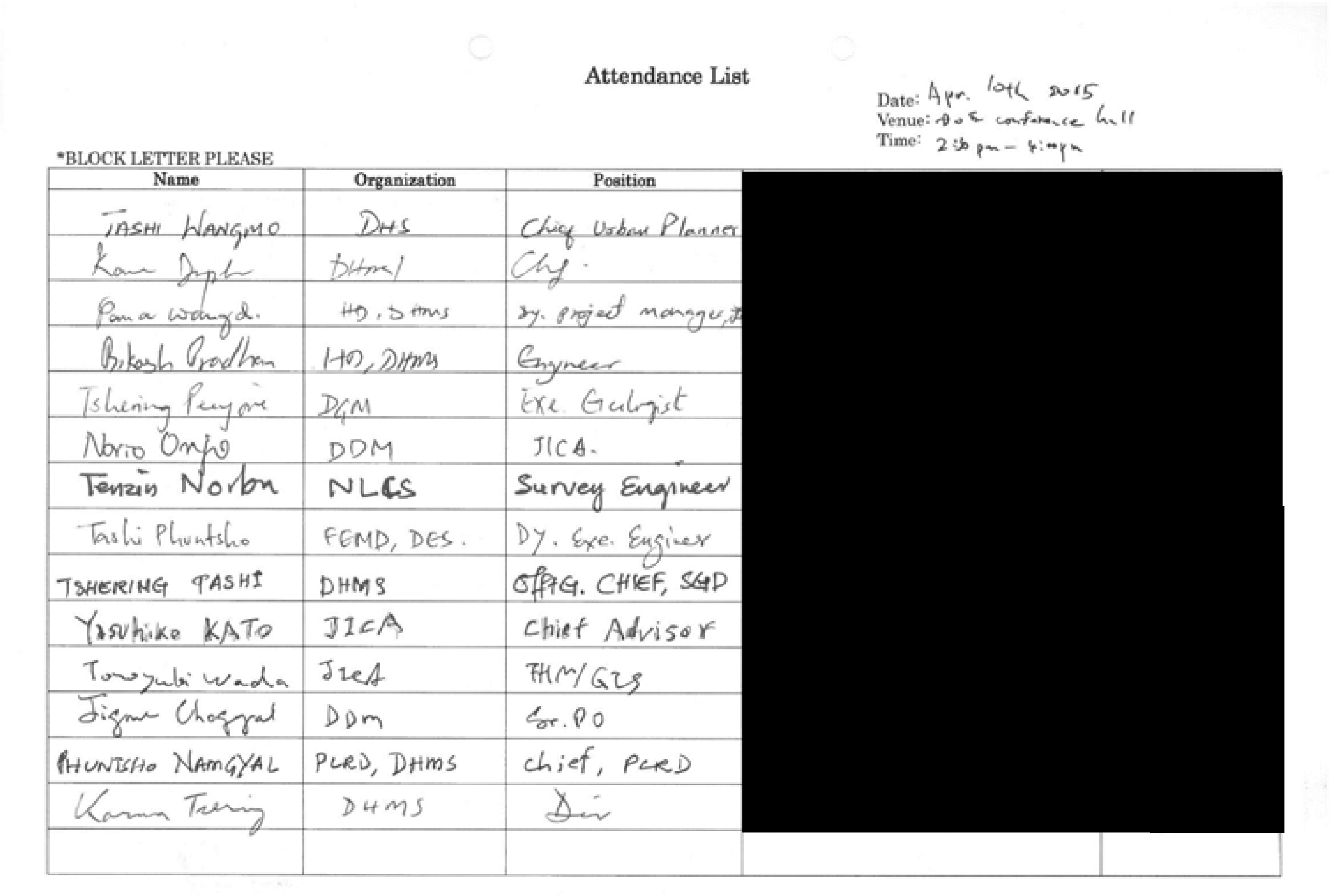
- Ms. Tashi Wangmo (DHS) presented on the usage of hazard map in the preparation of human settlement plans citing an example of Bumthang Valley Development Plan.
  - Bumthang Valley Development Plan (Structure Plan as general concept) was prepared by DHS in collaboration with the City of Zurich, Switzerland in 2013. The preparation of plan took into account the multi hazard map so as to mainstream disaster risk reduction.
  - Detailed Plans (Local Area Plan as Action Plan) for specific areas identified in the Valley Development Plan are also drafted by DHS in 2014 in order to implement detailed planning and zonation including land use demarcation.
  - The issue was raised since there are two hazard maps (one prepared by JICA through the Flood Hazard Map Working Group and the one by DHS) and the high hazard zones do not match.

Free Discussion (Activity 1-6 of the Project)

- (The coordination between the following three hazard zonation and the DHS's Draft Local Area Plans (Action Plan) at Wangdicholing in Bumthang were discussed.
    - DHS flood and geo hazard zonation
    - DGM GLOF hazard zonation
    - JICA GLOF/flood hazard zonation
- It was confirmed that JICA and DGM hazard zonation was almost the same at the Draft Local Area Plan site at Wangdicholing and DHS decided to apply the zonation into the Plan.
- It was confirmed that DHS hazard zonation covered wider area (safer side) than JICA/ DGM zonation taking into account not only GLOF/flood hazard but also other geo hazard.
- It was confirmed that there was no conflict between JICA flood hazard zonation and DHS Draft Local Area Plan at Wangdicholing.
- DDM suggested the Local Area Plan be finalized by applying JICA GLOF/flood hazard zonation and DHS geo hazard zonation.

Activities and Workshop Ahead

- The 5th W/G Workshop will be held on November 2015 (date to be announced). <u>Department of Roads, MoWHS and Department of School Education, Ministry of Education will be invited as observers.</u> The agenda will be as follows:
    - Presentation by Mr. Jigme Chogyal (DDM): Update on the disaster management administration in Bhutan after the enactment of Disaster Management Act 2013 (Activity 1-4)
    - Discussion on the proposal of institutional and legal system necessary for Mainstreaming Disaster Risk Reduction into Development Plan (Activity 1-7) <refer to P20 of Project Inception Report (Sep. 2013)>



Attendance List

Date: Apr. 10th 2015
Venue: DoE conference hall
Time: 2:30 pm – 4:00 pm

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
TASHI WANGMO	DHS	Chief Urban Planner	[redacted]	[redacted]
Karma Dupchu	DHMS	Chf.	[redacted]	[redacted]
Pema Wangd.	HD, DHMS	Dy. project manager,	[redacted]	[redacted]
Bikash Pradhan	HD, DHMS	Engineer	[redacted]	[redacted]
Tshering Penjore	DGM	Exe. Geologist	[redacted]	[redacted]
Norio Ongo	DDM	JICA.	[redacted]	[redacted]
Tenzin Norbu	NLCS	Survey Engineer	[redacted]	[redacted]
Tashi Phuntsho	FEMD, DES.	Dy. Exe. Engineer	[redacted]	[redacted]
TSHERING TASHI	DHMS	OFFTG. CHIEF, SGD	[redacted]	[redacted]
Yasuhiko KATO	JICA	Chief Advisor	[redacted]	[redacted]
Tomoyuki Wada	JICA	FHM/GIS	[redacted]	[redacted]
Jigme Choggyal	DDM	Sr. PO	[redacted]	[redacted]
PHUNTSHO NAMGYAL	PCRD, DHMS	chief, PCRD	[redacted]	[redacted]
Karma Tsering	DHMS	Dir	[redacted]	[redacted]

DHMS &JICA Expert Team
February 24, 2016

Memorandum
5thMDRR Working Group Workshop

General

The 5th workshop of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on February 24, 2016 from 11:00 to 12:30 at DHMS conference hall. The objective is to discuss the Project Activity 1-7, "Identify and propose institutions necessary for mainstreaming disaster risk reduction (MDRR) into development" <refer to P24 of Project Inception Report (Sep. 2013)>.

The W/G members from the counterpart agencies, DHMS, DDM, DGM, DoES attended the workshop. In addition, a representative from the Department of School Education (DoSE), Ministry of Education also attended the workshop as a new W/G member. The participants list is as attached as annexure. The main issues discussed are as follows:

Outline of the Inter-Ministerial Task Force (IMTF)

- Mr. Jigme Chogyal (DDM) explained the outline of the Inter-Ministerial Task Force (IMTF) to be established according to the Disaster Management Act of Bhutan 2014.

Topics of interest on the draft TOR of IMTF

5thWorkshop at DHMS

- Mr. Yasuhiko Kato, Chief Advisor of the JICA Expert Team present the topics of interest
  - ➢ DDM regarded IMTF as appropriate institutions for the MDRR into development.
  - ➢ Therefore, existing 2 W/G will be upgraded to the IMTF as it is.
    - ✧ Flood Hazard Map (FHM) W/G
    - ✧ Mainstreaming Disaster Risk Reduction (MDRR) W/G
  - ➢ The terms of reference (TOR) of the IMTF will be submitted to NDMA by DDM in 2016
  - ➢ The contents of the draft TOR of the IMTF will be as follows:
    - ✧ Permanent IMTF
    - ✧ Hazard based Temporal IMTFs
    - ✧ Exceptional crisis
    - ✧ Member list
    - ✧ Interval

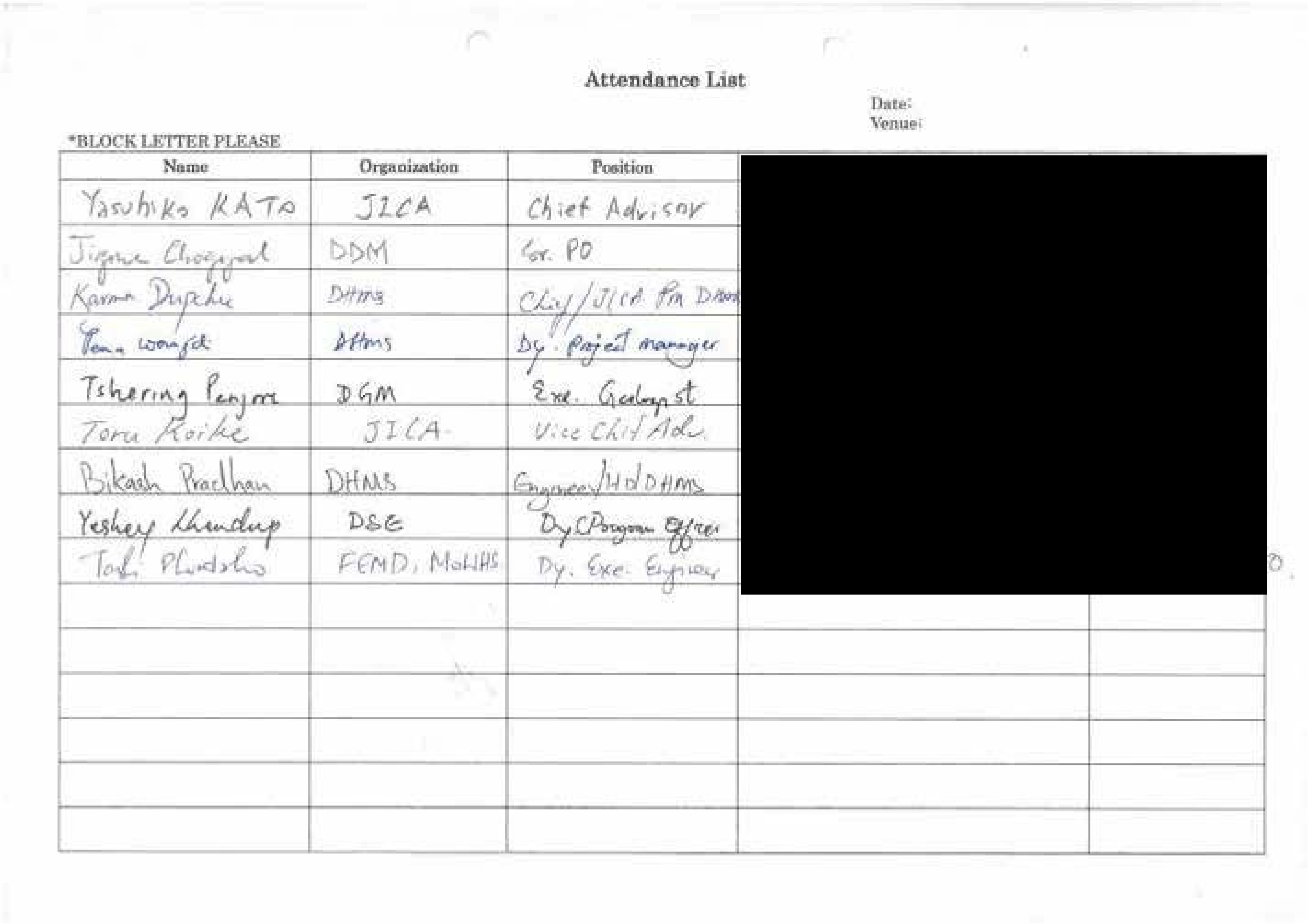
- ✧ Venue

Free Discussion (brainstorming) on the Draft IMTF TOR

- It was informed that JAXA/ AIT have interest in the Flood Hazard Map (FHM) W/G of the Project and had a meeting with the W/G members on Feb. 18 to promote future cooperation.
- It was proposed to use "Technical Working Group" instead of IMTF, however, it was agreed to use IMTF as it is considering the consistency with the DM Act 2013
- It was proposed that IMTFs should be hazard based such as Hydrological hazard (flood and windstorm, landslide? and draught) IMTF, Earthquake IMTF, Forest Fire IMTF and Epidemic IMTF
- It was proposed that the number of IMTFs will be 4 to 5 (Not too many IMTFs).
- It was proposed that the Permanent IMTF to discuss general DM issues will not be necessary.
- It was proposed to add City Corporation and the Department of Culture as the member of the IMTF for Earthquake.
- It was proposed to add the Department of Livestock as the member of the IMTF for Epidemic.
- Mr. Jigme Chogyal (DDM) agreed to prepare the Draft TOR of the IMTF as the basis for the continuous discussion on the next (6th) MDRR W/G Workshop to be held on May 2016.

Activities and Workshop Ahead

- The 6th W/G Workshop will be held on May 2016 (date to be announced). The agenda will be as follows:
    - ➢ Project Activity 1-7: Continuous discussion on the Draft TOR of the IMTF to be prepared by Mr. Jigme Chogyal (DDM)
    - ➢ Project Activity 1-9: Discussion on "Develop SOP on emergency information sharing through discussion and workshops with relevant agencies".<refer to P25 of Project Inception Report (Sep. 2013)>



Attendance List

Date:
Venue:

*BLOCK LETTER PLEASE

Name	Organization	Position	[redacted]	[redacted]
Yasuhiko KATO	JICA	Chief Advisor	[redacted]	[redacted]
Jigme Choegyal	DDM	Sr. PO	[redacted]	[redacted]
Karma Dupchu	DHMS	Chief/JICA PM DHM	[redacted]	[redacted]
Pema Wangdi	DHMS	Dy. Project manager	[redacted]	[redacted]
Tshering Penjore	DGM	Exe. Geologist	[redacted]	[redacted]
Toru Koike	JICA	Vice Chif Adv	[redacted]	[redacted]
Bikash Pradhan	DHMS	Engineer/HD DHMS	[redacted]	[redacted]
Yeshey Lhendup	DSE	Dy. Program Officer	[redacted]	[redacted]
Tashi Phuntsho	FEMD, MoWHS	Dy. Exe. Engineer	[redacted]	[redacted]

DHMS &JICA Expert Team
June 7, 2016

Memorandum

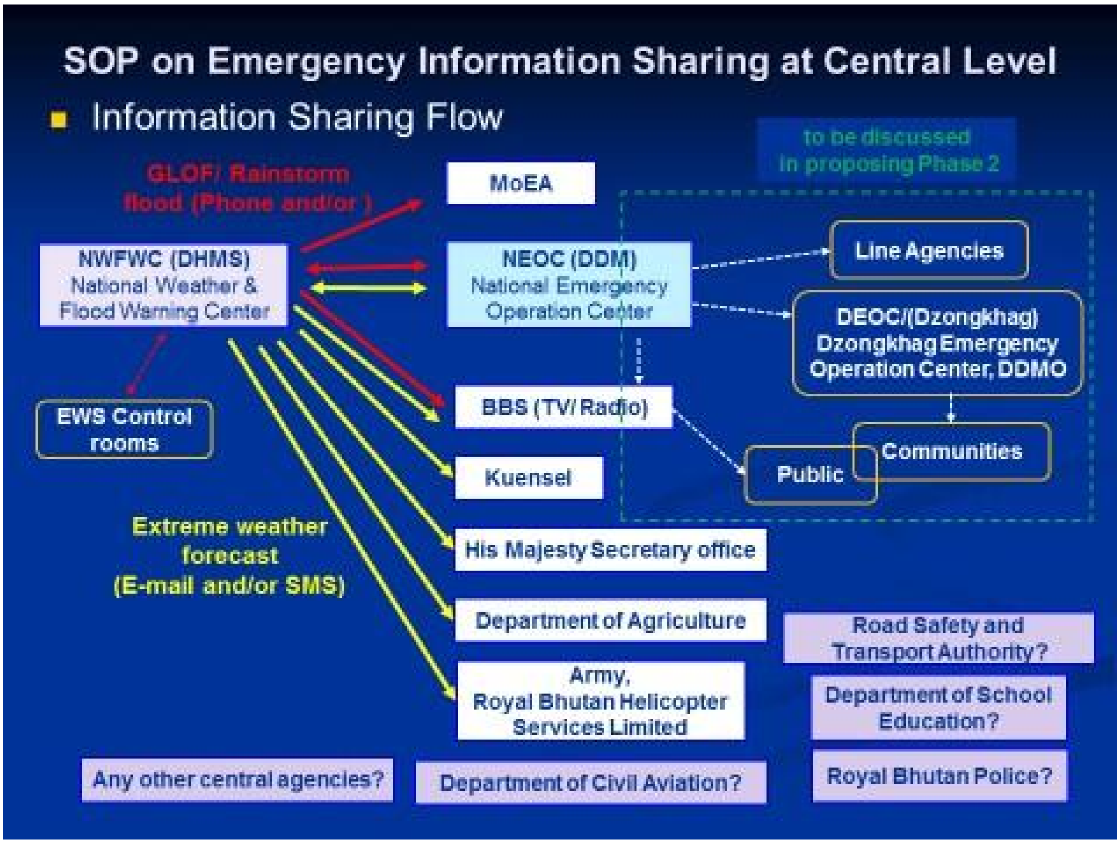
6th MDRR Working Group Workshop

General

The 6th workshop of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on June 7, 2016 from 11:00 to 12:40 at DHMS conference hall. The objective of the Workshop is to discuss the Project Activity 1-9, "Develop SOP (Standard Operation Procedure) on emergency information sharing through discussion and workshops with relevant agencies" in central level described in the PDM of the Project. 10 W/G members from the counterpart agencies, DHMS, DDM, DHS, DoSE and the JICA Expert Team attended the workshop. The participants list is as attached as annexure. The main issues discussed are as follows:

Topics of interest on the Emergency Information Sharing in Central Level

- Mr. Yasuhiko Kato, Chief Advisor of the JICA Expert Team presented the current status of the emergency information sharing in central level as a basis for the discussion to prepare the SOP.
    - The objective emergency information issued by NWFWC, DHMS will be
        - GLOF/rainstorm flood (hydrological information) and
        - Extrema weather forecast (meteorological information).
    - Current emergency information sharing flow between central agencies in Thimphu



SOP on Emergency Information Sharing at Central Level

- Information Sharing Flow

to be discussed
in proposing Phase 2

GLOF/ Rainstorm
flood (Phone and/or)

MoEA

NWFWC (DHMS)
National Weather &
Flood Warning Center

NEOC (DDM)
National Emergency
Operation Center

Line Agencies

DEOC/(Dzongkhag)
Dzongkhag Emergency
Operation Center, DDMO

EWS Control
rooms

BBS (TV/ Radio)

Kuensel

Public

Communities

Extreme weather
forecast
(E-mail and/or SMS)

His Majesty Secretary office

Department of Agriculture

Road Safety and
Transport Authority?

Army,
Royal Bhutan Helicopter
Services Limited

Department of School
Education?

Any other central agencies?

Department of Civil Aviation?

Royal Bhutan Police?

Visit to NWFWC

To have more clear image on the emergency information source, all the participants visited NWFWC to see the GLOF/Rainstorm Early Warning Systems (EWS) in three river basins (GLOF/flood information) and the GTS and HimawariCast receiver (Extreme weather forecast) installed by the Project.

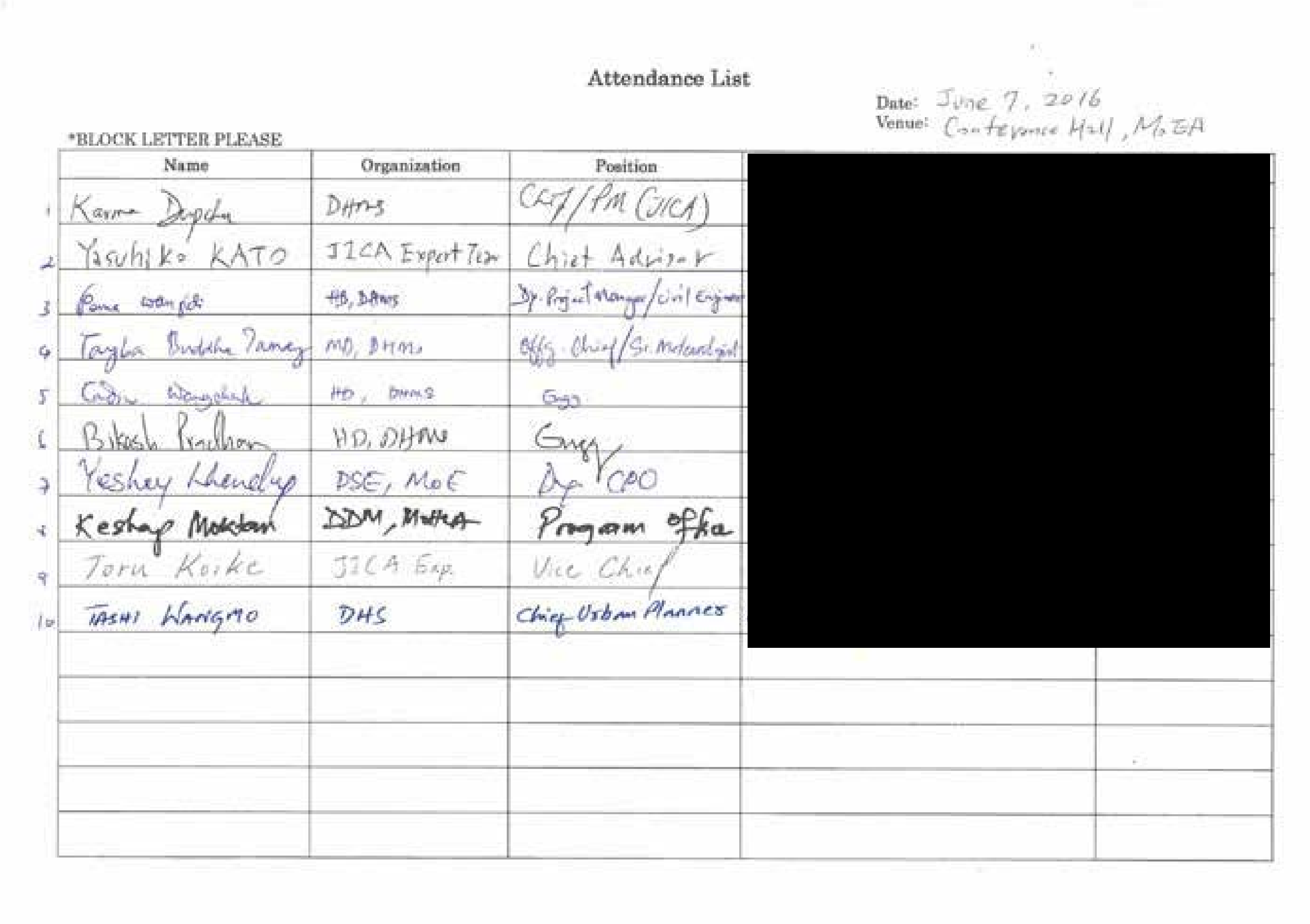
Free Discussion (brainstorming) on emergency information sharing in central level

- It was proposed that the SOP be divided into two part as follows because of the reason as below:
  - GLOF/rainstorm food (happens in specific basin wide, information sharing will be limited)
  - Extreme weather forecast (general and covering whole Bhutan, information sharing will be broader than GLOF/flood)
- Several problems on the sharing method were reported and discussed as below:
  - SMS: sometime delay (maximum around 1 day)
  - E-mail: Almost nobody could access after office hour
  - Web site: It is difficult to know the timing to access (Some may not know approaching emergency at all.)
- It was reported by, DHMS that, a new weather and flood alert apps is under development under the support of G2C (government to citizen) project. It is expected to launch soon.
- It was proposed that SNS (Social Networking Service) will also be one of the useful tool for the sharing.
- It was proposed that SMS, E-mail and other method should be official (for example issuing SMS from personal mobile will not be recommended.)

- It was reported by the Department of School Education (DoSE) that around 25 % of Bhutanese population is in school during daytime. (DoSE should be included in the information sharing as a new stakeholder.)
- It was proposed that the Road Safety and Transport Authority (RSTA) and Royal Bhutan Police (RBP) be included in the information sharing as a new stakeholder, as RSTA and RBP are directly responsible of monitoring of vehicles movements.
- It was agreed that the SOP be formulation by July 2016 as the project will be terminated by September 2016.

Activities and Workshop Ahead

- The 7th W/G Workshop will be held on July 2016 (date to be announced). The agenda will be as follows:
  - Project Activity 1-7: Continuous discussion on the Draft TOR of the IMTF by Mr. Jigme Chogyal (DDM)
  - Project Activity 1-9: Continuous discussion on "Develop SOP on emergency information sharing through discussion and workshops with relevant agencies" based on the draft SOP.



Attendance List

Date: June 7, 2016
Venue: Conference Hall, MoEA

*BLOCK LETTER PLEASE

	Name	Organization	Position	[redacted]	[redacted]
1	Karma Dupchu	DHMS	CPT/PM (JICA)	[redacted]	[redacted]
2	Yasuhiko KATO	JICA Expert Team	Chief Advisor	[redacted]	[redacted]
3	Pema Wangdi	HB, DHMS	Dy. Project Manager/Civil Engine	[redacted]	[redacted]
4	Tayba Buddha Tamang	MD, DHMS	Offg. Chief/Sr. Meteorologist	[redacted]	[redacted]
5	Cedun Wangchuk	HD, DHMS	Engr	[redacted]	[redacted]
6	Bikash Pradhan	HD, DHMS	Engr	[redacted]	[redacted]
7	Yeshey Khendup	DSE, MoE	Dy. CPO	[redacted]	[redacted]
8	Keshap Moktan	DDM, MoHCA	Program Officer	[redacted]	[redacted]
9	Toru Koike	JICA Exp.	Vice Chief	[redacted]	[redacted]
10	TASHI WANGMO	DHS	Chief Urban Planner	[redacted]	[redacted]

DHMS &JICA Expert Team
Aug 2, 2016

Memorandum
7th MDRR Working Group Workshop

General

The 7th workshop of Mainstreaming Disaster Risk Reduction (MDRR) Working Group (W/G) was held on Aug 2, 2016 from 11:00 to 12:45 at DHMS conference hall. The objective of the Workshop is to discuss the following issues described in the PDM of the Project:

1. Project Activity 1-7, "Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans." and,
2. Project Activity 1-9, "Develop SOP (Standard Operation Procedure) on emergency information sharing through discussion and workshops with relevant agencies" in central agencies.

Seven W/G members from the counterpart agencies, DHMS, DDM, DHS and the JICA Expert Team attended the workshop. The participants list is as attached as annexure. The main issues discussed are as follows:

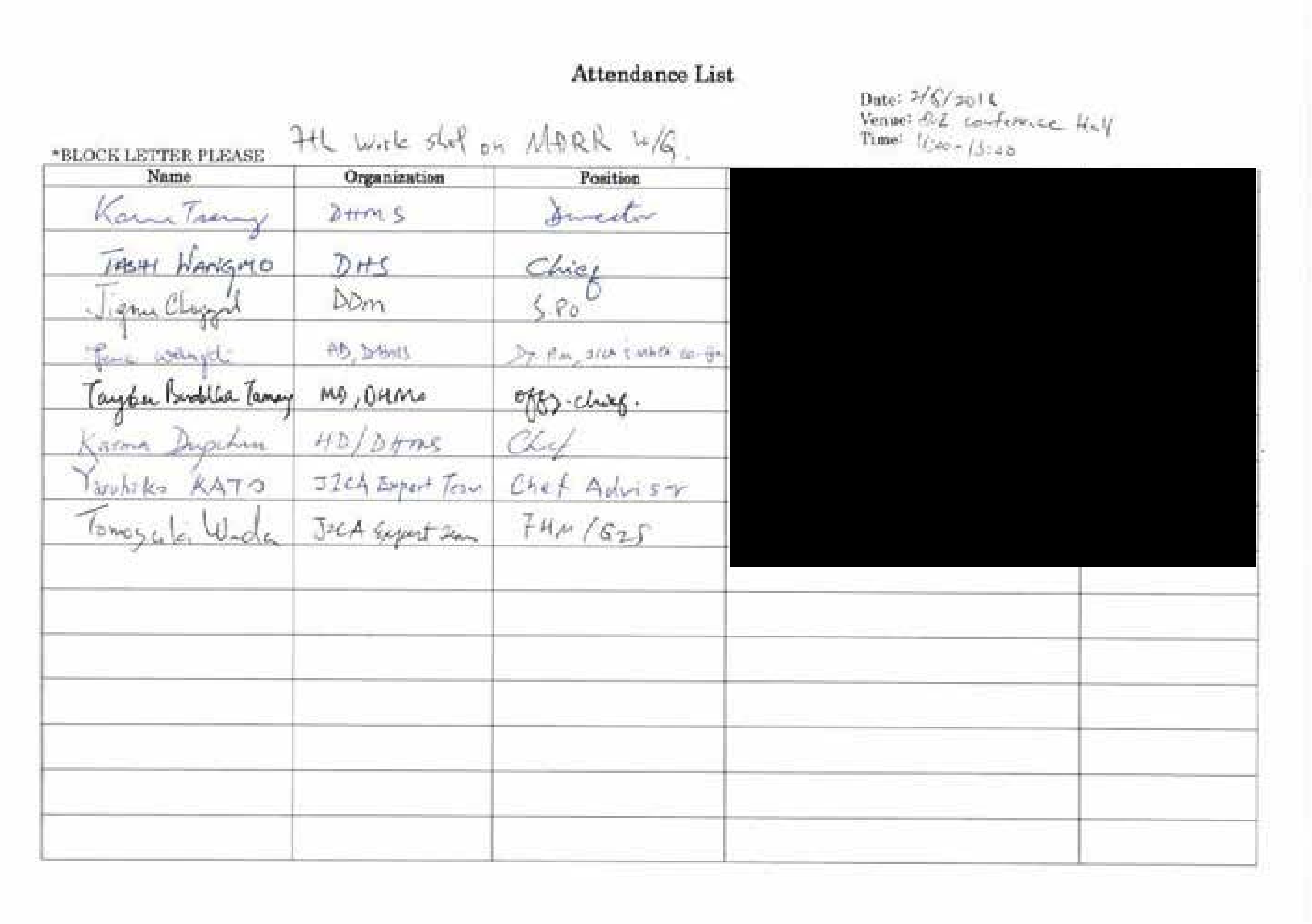
Project Activity 1-7, "Identify and propose institutions necessary for mainstreaming disaster risk assessment information into development plans."

- Presentation
  - Mr. Jigme Chogyal, DDM presented the draft Terms of Reference (TRO) for Flood Hazard Technical Working Group - Bhutan (FTWG) of Inter-Ministerial Task Force (IMTF)
- Discussion
  - The original idea of organizing IMTF with 15 members will not be useful, practical and functioning.
  - A Technical Working Group (W/G) under IMTF will be organized for each disaster as necessary.
  - It is suggested that the W/G is for review and advice and not for carrying out practical work like hazard mapping.
  - The W/G will review and advice not only the flood hazard map prepared by the technical agencies in charge but also the Disaster Management and Contingency Plan prepared by each Dzongkhag.
  - Almost the same W/G members will be able to deal with landslide.

- Mr. Jigme Chogyal, DDM will update and distribute the TOR to today's participants based on this discussion
- DDM will submit the final TOR to next NDMA

Project Activity 1-9, "Develop SOP (Standard Operation Procedure) on emergency information sharing through discussion and workshops with relevant agencies"

- Presentation
  - Mr. Yasuhiko Kato, Chief Advisor of the JICA Expert Team presented draft "Standard Operation Procedure (SOP) on Emergency Information Sharing in Central Agencies" prepared based on the discussion in the last (6th) MDRR W/G Workshop held on June 7, 2016.
- Discussion
  - Other than SNS, the effectiveness of the group information sharing using chatting application, especially "WeChat" (very popular in Bhutan) is introduced. "WeChat" group is used for the communication between DDM and the DDMO in 20 Dzongkhag.
  - The point of contact of NWFWC should be official telephone number and should not be only personal mobile number.



Attendance List

Date: 2/8/2016
Venue: [illegible] conference Hall
Time: 11:00-13:00

*BLOCK LETTER PLEASE 7th Workshop on MDRR W/G.

Name	Organization	Position	[redacted]	[redacted]
Karma Tsering	DHMS	Director	[redacted]	[redacted]
TASHI WANGMO	DHS	Chief	[redacted]	[redacted]
Jigme Chogyal	DDM	S.PO	[redacted]	[redacted]
[illegible]	AD, DHMS	[illegible]	[redacted]	[redacted]
Tayba Buddha Tamang	MD, DHMS	offg. chief.	[redacted]	[redacted]
Karma Dupchu	HD/DHMS	Chief	[redacted]	[redacted]
Yasuhiko KATO	JICA Expert Team	Chief Advisor	[redacted]	[redacted]
Tomoyuki Wada	JICA Expert Team	FHM/GIS	[redacted]	[redacted]

Appendix　12

Handover Document on Equipment and Facilities Supplied

Japan International Cooperation Agency

CERTIFICATE OF HANDOVER

PROJECT TITLE: **“The Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan”**

This is to certify that the equipment in the attached list for above-mentioned project have been handed over properly as of 26, August, 2016 to the Department of Hydro-Met Services, Ministry of Economic Affairs.

山田浩司

Mr. Koji YAMADA
Chief Representative
JICA Bhutan Office

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

26, August, 2016

(Department of Hydro-Met Services)

JICA Bhutan Office
Doybum Lam, Above Memorial Chorten, P.O. Box 217, Thimphu, BHUTAN
TEL: 322030, 323218, 328074 FAX: 323089, E-mail: bt_oso_rep@jica.go.jp
URL:http://www.jica.go.jp/bhutan

List of Equipment Provided by the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan (1/3)

No.	Name of Equipment	Amount
1	Equipment for the Global Telecommunication System (GTS)/ Message Switching System (MSS) (including the operating system and manual)	1
2	Equipment for the GLOF/Rainstorm Early Warning System (EWS) along the Mangdechhu and Chamkharchhu River Basins (including AWLS, AWS, control room, waning siren, communication system and the operating system and manual)	1

Undertakings of the Department of Hydro-Met Services, MoEA

The above-listed equipment (GTS/MSS and EWS) shall be operated and maintained properly and sustainably under the responsibility of the Department of Hydro-Met Services, Ministry of Economic Affairs by securing sufficient budget as proposed in the Project Completion Report of the Project (refer to Section 4.3.2).

Warranty against Defects by Japanese Side

The Contractor (Helicom Corporation Inc.) is required to warrant the quality of above-listed equipment (GTS/MSS and EWS) during one (1) year from the date of the completion officially certified by JICA Headquarter on March 23, 2016. Defects to be warranted are as follows:

1) Malfunctioning or breaking of the equipment due to use of improper equipment or materials
2) Malfunctioning or breaking of the equipment due to use of improper software

Notwithstanding above, the Contractor will be exempted from the responsibility of warranty, if the malfunctioning or breaking are caused by a third party, modification from the original installation condition, improper operation and maintenance, force majeure such as landslide, earthquake or extraordinarily big flood.

List of Equipment Provided by the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan (2/3)

No.	Name of Equipment	Amount
3	Equipment for the HimawariCast Receiving System (including the operating system and manual)	1

Undertakings of the Department of Hydro-Met Services, MoEA

The above-listed equipment (GTS/MSS and EWS) shall be operated and maintained properly and sustainably under the responsibility of the Department of Hydro-Met Services, Ministry of Economic Affairs by securing sufficient budget.

Warranty against Defects

The Contractor (Oriental Electronics, Inc.) is required to warrant the quality of above-listed equipment (HimawariCast Receiving System) during one (1) year from the date of the official completion certified by JICA Expert Team on March 11, 2016. Defects to be warranted are as follows:

1) Malfunctioning or breaking of the equipment due to use of improper equipment or materials
2) Malfunctioning or breaking of the equipment due to use of improper software

Notwithstanding above, the Contractor will be exempted from the responsibility of warranty, if the malfunctioning or breaking are caused by a third party, modification from the original installation condition, improper operation and maintenance or earthquake.

List of Equipment Provided by the Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Early Warning in the Kingdom of Bhutan (3/3)

No.	Name of Equipment	Amount
4	Backup Generator for the GTS/MSS and the EWS	3
5	Equipment for the flood evacuation drills (including head lamp, reflectorized vest, megaphone, stretcher, first aid kit, tarpaulin and rope) for the following target communities: - Mangdechhu basin; Bjizam community - Chamkharchhu basin: Wangdicholing and Chamkhar Town communities and Gangrithang and Chokhortoe primary schools	1
6	Computer (DELL Latitude E6440)	1
7	Multifunction Photocopier (bizhub C224e/Konica Minolta)	1
8	A0 Plotter (HP Designjet T520)	1
9	Projector (XJA141/CASIO)	1
10	GPS (Promark120/Spectra Precision)	2
11	Range finder (True Pulse 200/Laser Technology, Inc.)	2

Warranty against Defects
(Above-listed equipment are exempted from warranty against defects.)

Appendix　13

Minutes of Meetings of Project Completion Report

MINUTES OF MEETINGS
ON
THE PROJECT COMPLETION REPORT
FOR
THE PROJECT FOR CAPACITY DEVELOPMENT OF GLOF AND RAINSTORM FLOOD FORECASTING AND EARLY WARNING

AGREED UPON BETWEEN
THE AUTHORITIES CONCERNED
OF THE GOVERNMENT OF KINGDOM OF BHUTAN
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Thimphu, August 29, 2016

加藤泰彦

Mr. Yasuhiko Kato
Chief Advisor, Expert Team
Japan International Cooperation Agency
(JICA)

Mr. Karma Tsering
Director
Department of Hydro-Met Services
Ministry of Economic Affairs

In response to the request of the Government of Kingdom of Bhutan, the Government of Japan has decided to conduct the technical cooperation concerning the "Project for Capacity Development of GLOF and Rainstorm Flood Forecasting and Warning"(hereinafter referred to as "the Project"). The Japanese side and the Bhutanese side came to an agreement on the Record of Discussion (hereinafter referred to as "R/D") which was signed on 14 May 2013 between Gross National Happiness Commission and Japan International Cooperation Agency (hereinafter referred to as "JICA"). Based on the R/D, JICA dispatched the Expert Team (hereinafter referred to as "the Team") headed by Mr. Yasuhiko Kato from 9 October 2013 for the commencement of the Project.

The Project Completion Report (hereinafter referred to as "the Report") meeting was held on August 26, 2016 with main counterpart agency, Department of Hydro-Met Services, Ministry of Economic Affairs (hereinafter referred to as "DHMS") and five sub counterpart agencies concerned with the Project to discuss the contents of the Report compiling all the progress and achievements of the Project for 3 years from October 2013 to August 2016. The list of the participants is attached as Annex 1.

The Report was accepted by the Bhutanese side in principle. The following are the main points discussed and agreed by the both sides.

1. Achievements of the Project

   The achievements of the Project which were carried out for 3 years from October 2013 to August 2016 by predominantly the counterpart personnel with support from the Team was agreed upon and accepted by the Bhutanese side.

2. Active involvement of DHMS staff to the equipment installation work

   The team expressed deep gratitude to DHMS for dispatching may staff for several months, at its own expenses, to support the installation work of the GTS/MSS, EWS and Himawari Cast Receiving System conducted by JICA Contractor in Thimphu, Mangdechhu and Chamkharchhu river basins.

3. Official handover of the equipment

   All the equipment provided and installed (GTS/MSS, EWS, HimawariCast Receiving System and others) have been officially handed over from JICA to DHMS as of 26, August, 2016. The Team requested that the equipment be operated and maintained properly and sustainably under the responsibility of DHMS by securing sufficient budget as proposed in the Section 4.3.2 of the Report. The Team informed that JICA Headquarter has officially requested JICA Contractor to come to Bhutan to fix several minor malfunctioning of the EWS as soon as possible based on the warranty against defects. The Bhutanese side agreed with the request and information.

4. Support of DDM and DHMS for Bumthang District Office on future EWS Sensitization

It was acknowledged by the participants that one of the important lessons learned from the last big monsoon flood in Bumthang on July 26, 2016 is the importance and necessity of further and continuous sensitization by Bumthang District Office on the EWS installed by the Project, which will not only be the periodical evacuation mock drill at vulnerable communities but also the general awareness raising for other general public inhabited in entire Bumthang valley. In this context, DDM and DHMS agreed to support Bumthang District Office financially and technically for their future sensitization activities.

Annex-1

Participant List of Project Completion Report Meeting

Bhutanese Side:

Mr. Karma Tshering	Director, DHMS (Project Director)
Mr. Karma Dupchu	Chief of Hydrology Division, DHMS (Project Manager)
Mr. Pema Wangdi	Engineer, Hydrology Division, DHMS (Deputy Project Manager)
Mr. Bikash Pradhan	Engineer, Hydrology Division, DHMS
Mr. Sangay Tenzin	Assistant Engineer, Hydrology Division, DHMS
Mr. Kunzang	Assistant Engineer, Hydrology Division, DHMS
Mr. Tayba B Tamang	Off. Chief of Meteorology Division, DHMS
Mr. Cheki Dorji	Engineer, Meteorology Division, DHMS
Ms. Pema Syldon	Engineer, Meteorology Division, DHMS
Mr. Chhimi Wangda	Asst. Meteorologist Officer, Meteorology Division, DHMS
Mr. Ranjit Tamang	Senior. Technician, Meteorology Division, DHMS
Mr. Karma Tenzin	Senior. Technician, Meteorology Division, DHMS
Mr. Tshering Tashi	Off. Chief of Snow & Glacier Division, DHMS
Mr. Somik Mukherjee	Head/TMO, Flood Warning Section, DHMS

Mr. Jigme Chogyal	Program Officer, DDM
Mr. Tshering Penjore	Executive Geologist, DGM
Mr. Tashi Phuntsho	Dy. Executive Engineer, Flood Engineering Management Division, DoES
Ms. Tashi Wangmo	Chief Urban Planner, Survey & GIS Division, DHS
Mr. Dorji Pelzang	Sr. Survey Engineer, NLCS

Japanese Side:

Ms. Kazumi Shimaoka	Project Formulation Advisor, JICA Bhutan Office
Mr. Yasuhiko Kato	Chief Advisor/ Basin Disaster Management Planning
Mr. Toru Koike	Vice Chief Advisor/ Flood Forecasting and Warning
Mr. Tomoyuki Wada	Flood Hazard Map/ GIS