DEPARTMENT OF METEOROLOGY
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE PROJECT FOR IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

AUGUST 2017

JAPAN INTERNATIONAL COOPERATION AGENCY
INTERNATIONAL METEOROLOGICAL CONSULTANT INC.
JAPAN WEATHER ASSOCIATION
JICA LONG TERM EXPERT

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List of Abbreviations

AWS	:	Automatic Weather System
BUFR	:	Binary Universal Form for the Representation of meteorological data
CAPE	:	Convective Available Potential Energy
CFS	:	Climate Forecast System
C/P	:	Counterpart
COMS	:	Communication, Ocean and Meteorological Satellite of Korea
CRED	:	Centre for Research on the Epidemiology of Disasters
DMC	:	Disaster Management Centre
DOM	:	Department of Meteorology
EM-DAT	:	Emergency Events Database
FTP	:	File Transfer Protocol
GDP	:	Gross Domestic Product
GFS	:	Global Forecast System
GPV	:	Grid Point Vale
GTS	:	Global Telecommunication System
ICTA	:	Information and Communication Technology Agency of Sri Lanka
IEC	:	International Electrotechnical Commission
ISO	:	International Organization for Standardization
IMF	:	International Monetary Fund
IP-VPN	:	Internet Protocol Virtual Private Network
JCC	:	Joint Coordinating Committee
JICA	:	Japan International Cooperation Agency
JMA	:	Japan Meteorological Agency
MOS	:	Model Output Statistics
MSS	:	Message Switching System

NOAA	:	National Oceanic and Atmospheric Administration
NWP	:	Numerical Weather Prediction
OFDA	:	Office of U.S. Foreign Disaster Assistance
PDM	:	Project Design Matrix
RMSE	:	Root Mean Square Error
ROD	:	Record of Discussions
SADIS	:	Secure Aviation Data Information Service
SATAID	:	Satellite Animation and Interactive Diagnosis
SMS	:	Short Message Service
SSI	:	Showalter Stability Index
VSAT	:	Very Small Aperture Terminal
WAFS	:	World Area Forecast System
WHO	:	World Health Organization
WIS	:	WMO Information System
WMO	:	World Meteorological Organization
WRF	:	Weather Research and Forecast

Exchange Rates of Currency assigned by JICA

Month	Japanese Yen/ 1US$	Japanese Yen/ 1 Sri Lanka Rupee
FY2014		
9	98.04	0.736
10	98.29	0.752
11	98.25	0.750
12	102.19	0.779
1	104.71	0.801
2	102.46	0.784
3	102.20	0.780
FY2015		
4	102.82	0.787
5	102.58	0.786
6	101.68	0.780
7	103.41	0.780
8	102.39	0.787
9	103.77	0.797
10	109.45	0.843
11	109.06	0.834
12	117.58	0.897
1	120.48	0.918
2	117.93	0.909
3	119.03	0.916

Month	Japanese Yen/ 1US$	Japanese Yen/ 1 Sri Lanka Rupee
FY2016		
4	113.393000	0.787000
5	111.099000	0.775400
6	110.333000	0.748300
7	102.280000	0.707200
8	105.440000	0.738100
9	102.129000	0.713200
10	100.606000	0.700300
11	104.758000	0.728000
12	112.305000	0.774700
1	117.382000	0.801930
2	115.144000	0.783560
3	112.217000	0.749110
FY22017		
4	111.083000	0.737240
5	111.313000	0.740410
6	111.326000	0.734260
7	112.185000	0.741120

Source: JICA Website *http://www.jica.go.jp/announce/manual/form/consul_g/rate.html*

1. Outline of the Project (Background, Objectives and Circumstances)

1-1 Background of the Project

The Democratic Socialist Republic of Sri Lanka (hereinafter referred to as Sri Lanka) is suffering annually from floods and landslides caused by torrential rains. The torrential rain that occurred in May 2003 caused serious floods and landslides inflicting damage to about 140,000 households and resulted to the loss of 235 lives. Property damage amounted to about 56 million U.S. dollars which is equivalent to 0.3% of the country's GDP. Furthermore, there were 38 recorded cases of floods and landslides in 2006. In both 2008 and 2011, large-scale and devastating occurrences of flooding happened 3 times for each year. In the past 20 years (1996-2015), more than 66% of the total population of 20.35 million (2012) people, which is approximately 13.5 million people, are reported to have been affected by major disasters caused by hazardous meteorological phenomena. It is, therefore, an urgent task for Sri Lanka to mitigate the damages and untoward consequences caused by meteorological disasters associated with torrential rains.

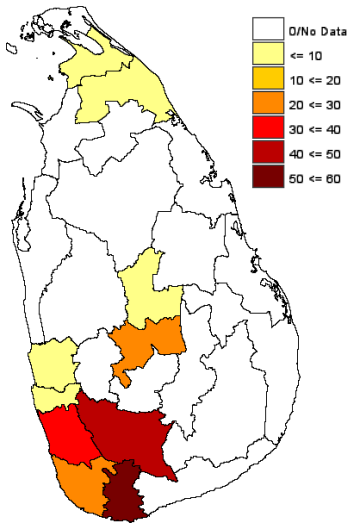

Figure 1: Deaths and Injured by Flood for 30 years (1985-2014)
Source: The United Nations Secretariat for International Strategy for Disaster Reduction (UNISDR)

While most of the northern areas are composed of flat lands, there lie mountains as high as 2,000 meters in the southern areas, represented by the Pidurutalagala (2,524m) in the central southern area, the highest peak in Sri Lanka. Rivers flow into the sea radially from the central highland. The upper basins of those rivers are precipitous and the middle and lower basins are extremely gradual. Therefore, landslides frequently occur in the upper basins where numerous waterfalls and rapid flows are formed on the steep slopes and cliffs. On the other hand, the middle and lower basins are easily flooded in case of heavy rain since the river waters flow too slowly to be drained smoothly into the sea.

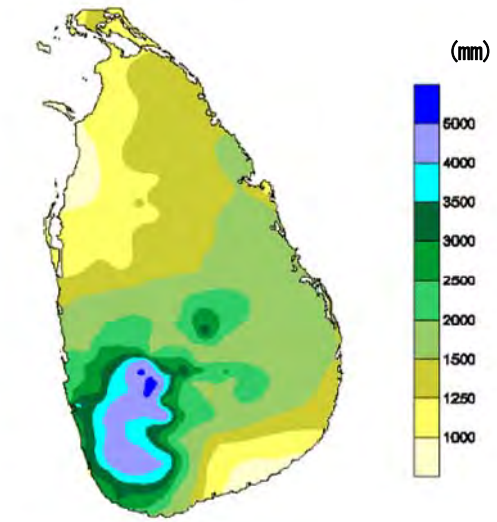

Figure 2: Annual Mean Precipitation Distribution
Source: The United Nations Secretariat for International Strategy for Disaster Reduction (UNISDR)

The rainfall in Sri Lanka is greatly influenced by its topography. The figure located on the right side presents the annual average precipitation distribution in Sri Lanka. Since the Southwest Monsoon (from May to September) blows in the southwestern slope of the mountains ranging in the southern part of Sri Lanka, there is a great deal of precipitation in the area. The annual mean precipitation is more than 3,000mm and there is even an area in the country where it reaches 5,000 mm. In addition, the amount of precipitation in the eastern part of Sri Lanka increases due to the Northeast Monsoon (from December to February) wherein the annual mean precipitation is more than 2,000mm. The rain distribution in Sri Lanka greatly changes by the direction where a monsoon blows in the Central Highlands and local heavy rains may occur due to the influence of the country's topography.

1-2 Meteorological Disasters in Sri Lanka

As shown in the figure on the right, various meteorological disasters occur in Sri Lanka throughout the year. The areas where these disasters happen are different seasonally and locally due to the topographic features of the country. Therefore, a timely and quantitative observation network which covers the entire country is essential in order to monitor disaster occurrence.

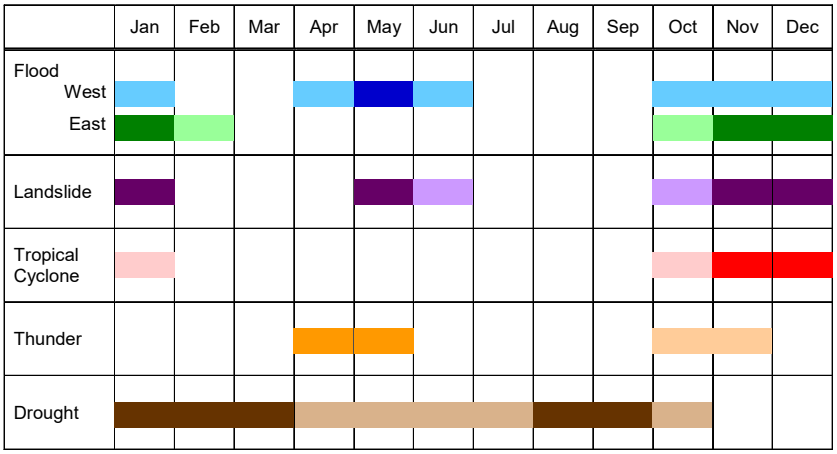

Figure 3: Meteorological Disaster Calendar in Sri Lanka

Source: Disaster Information Management System, Sri Lanka

In Sri Lanka, the meteorological disasters which bring about massive damages to the people and economy are floods or landslides caused by heavy rains which are attributed to monsoons or tropical cyclones. A significant disaster killing more than 10 people has happened almost every year since 2006 and the frequency of its occurrence has tended to increase.

Table 1: Meteorological Disasters in Sri Lanka during 2003-Middle of 2016
(Number of Killed or Missing Person: Over 10)

Year/Month	Season	Type of Disaster	Killed/Missing	Total Affected	Estimated Damage (US$ Million)
May 2003	Southwest Monsoon	Flood	235	695,000	29
October-November 2006	Second Inter-Monsoon	Flood	25	333,002	3
January 2007	Northeast Monsoon	Flood	18	35,000	-
May 2007	Southwest Monsoon	Flood	15	121,000	0.05
May-June 2008	Southwest Monsoon	Flash Flood	25	362,582	-
November 2008	Second Inter-Monsoon	Tropical Cyclone	15	360,000	-
May 2010	Southwest Monsoon	Flood	20	75,000	105
January 2011	Northeast Monsoon	Flood	47	1,060,324	200
February 2011	Northeast Monsoon	Flood	18	225,000	300
November 2011	Second Inter-Monsoon	Storm	22	35,041	-
December 2012	Northeast Monsoon	Flood	53	447,021	1.2
January 2013	Northeast Monsoon	Flood	52	56,747	-
June 2013	Southwest Monsoon	Flood	58	17,214	-
February 2014	Northeast Monsoon	Flood	27	-	-
June 2014	Southwest Monsoon	Flood	27	104,009	-
October 2014	Second Inter-Monsoon	Land Slide	38	330	-
October 2014	Second Inter-Monsoon	Land Slide	196	1,067	-
December 2014	Northeast Monsoon	Flood	41	1,100,020	-
May 2016	Southwest Monsoon	Flood	245	500,000	2,000

Source: WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED)
Emergency Events Database (EM-DAT)

Since more than 90% of the major disasters in Sri Lanka were caused by hazardous meteorological phenomena, meteorology has indeed become a matter of life or death in Sri Lanka. As such, the role of the DOM, the only meteorological organization in the country, is crucial and important.

1-3 Negative Impact on the Development of the Sri Lankan Economy

An agricultural sector centered on rice and plantation crops of tea, rubber, and coconut has traditionally driven the development of the market economy of Sri Lanka. A GDP (gross domestic product) growth rate of more than 10% was achieved due to the expansion of the

manufacturing and wholesale and retail industry under the government policy for economic development adopted in 1990. Since 1991, a GDP growth rate of 4.0% to 6.0% has been constantly maintained and a high rate of 8.0% in 2010 and 8.3% in 2011 were achieved due to the further intensification of economic activities which accelerated since the end of a quarter of a century civil war in 2009.

Throughout the course of the robust economic development achieved by Sri Lanka, negative impacts on the economy have been observed due to natural disasters as shown in the table presented below. The widespread drought indicated in the table hereunder which persisted until September 2001 (rainy season: from October to December in previous years) caused serious negative impacts to the district of Puttalam, which has a thriving agricultural and fisheries industry and is considered to be a place of strategic importance for the Sri Lankan economy, as well as to the district of Badulla, which is one of the major tea production regions in the country. From a 6.0% GDP growth rate in the previous year, a significant negative GDP growth rate of -1.6% was recorded with a total of one million affected people.

In 2008 when a GDP growth rate of 6.0% was recorded, it suddenly dropped to 3.5% in 2009. A similar case was observed during 2012 when the GDP growth rate dropped to 6.3% from 8.0% in 2011. In both instances, large-scale and devastating occurrences of river flood and flood happened 3 times in each year and approximately 0.8 million people were affected in 2008 while 1.3 million people were affected in 2011. Thus, there is a real and significant evidence that widespread and persistent disasters such as droughts and floods caused by weather phenomenon induces a major negative impact in the economic activity in Sri Lanka. It should be noted that the reduced impact on the GDP growth rate caused by an extensive tsunami disaster created by an earthquake in the Indian Ocean off Sumatra on December 26, 2004 is attributed to the intensification of international assistance and investments for reconstruction in the devastated areas.

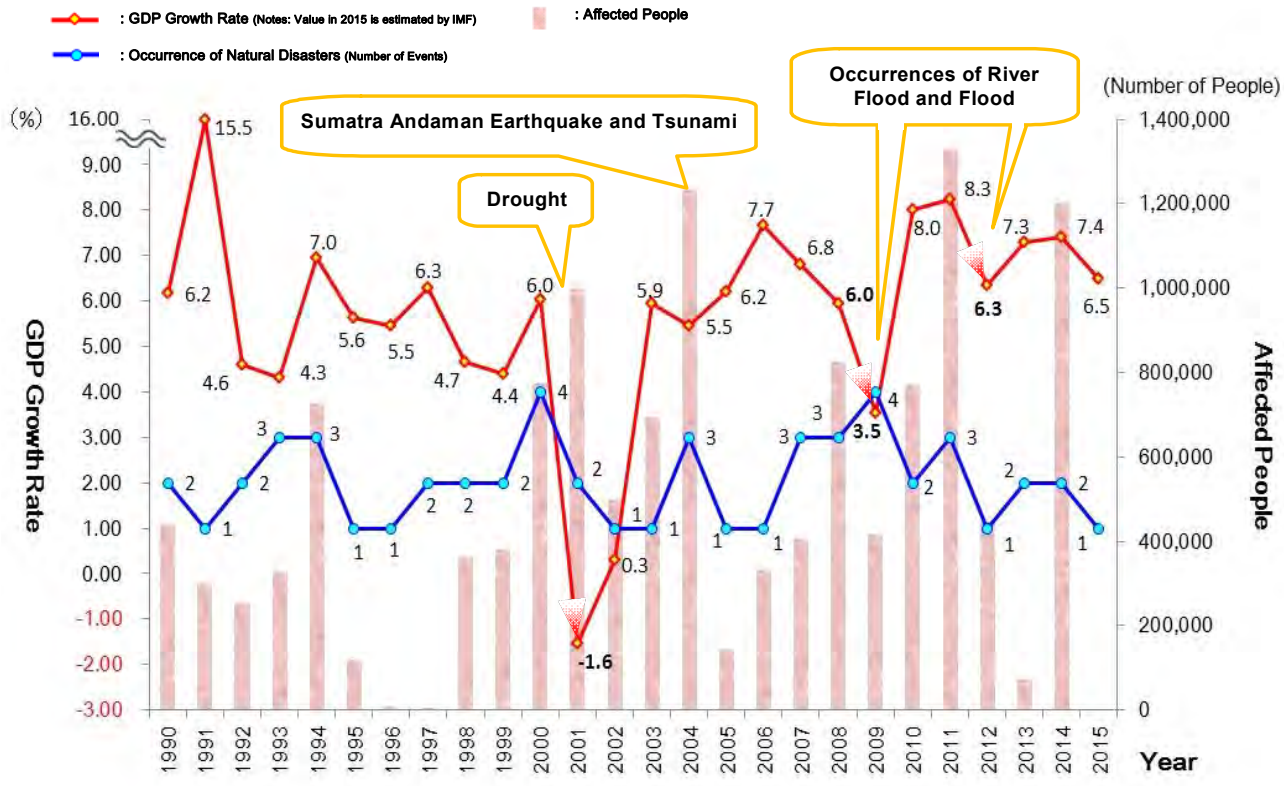

Figure 4: Meteorological Disaster, Number of Affected People by Disaster and GDP Growth Rate (1990-2015)

Source: IMF（International Monetary Fund） and EM-DAT: OFDA/CRED International Disaster Database

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1-4 Cooperation between Sri Lanka and Japan

The serious damages caused by the tsunami that attacked the country's coast facing the Indian Ocean in December 2004 are still fresh in our memory. In response to the severe disaster caused by the tsunami that affected 13 out of the 14 coastal districts facing the Indian Ocean in Sri Lanka, the Government of Japan extended assistance to Sri Lanka in the area of disaster management. The grant aid project "Improvement of Meteorological Information and Disaster Management Networks" is one example of Japanese cooperation in disaster management.

In particular, the equipment for meteorological observations and data network provided and introduced under the Japanese grant aid, "Improvement of Meteorological Information and Disaster Management Networks" (the official date of completion of the project was July 13, 2009; but the equipment was frequently damaged by lightning and needed repair and replacement, so the total functional system was delivered to Sri Lanka in July 2011) is closely related and connected to this Technical Cooperation Project. The figure on the right shows the

location map of the 38 observation stations installed under the grant aid program. The equipment for all the observation stations procured under Japan's grant aid is being handled, maintained and managed by the DOM.

In order for the DOM to mitigate the damages generated by the disasters caused by hazardous meteorological phenomena, it is a priority issue to detect hazardous meteorological phenomena which may create massive damages and disseminate highly accurate forecasts/warnings to the public more appropriately and promptly before the risk of disasters further escalate. Given all the circumstances mentioned above, it is significantly imperative to materialize urgently the further improvement of the technical capabilities of the DOM.

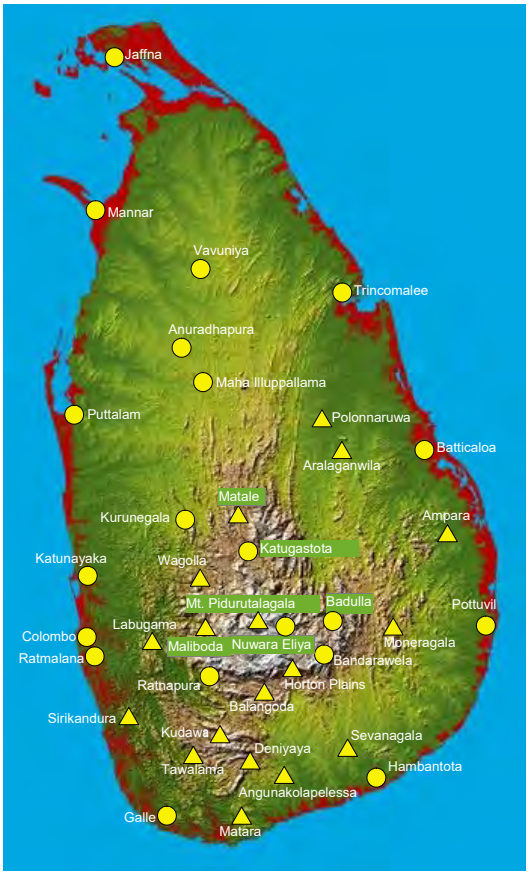


Figure 5: Location Map of 38 Meteorological Stations established by the Japan's Grant Aid + Head Office of the Department of Meteorology

Synoptic Meteorological Stations
Collaborator Stations

Cognizant of the aforementioned situation, the Government of Sri Lanka has requested the Government of Japan for this Technical Cooperation Project. In response to this request, the Japan International Cooperation Agency (hereinafter referred to as "JICA") held a series of discussions with the Government of Sri Lanka and concluded the Record of Discussions for the Project on May 23, 2014. Finally, it was decided to implement the Project beginning September 2014.

1-5 Objective of the Project

The objective of this Work is to achieve the Project Purpose by attaining the expected outputs described below through a variety of activities in accordance with PDM (Project Design Matrix).

1) Overall Goal

Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.

(Objectively Verifiable Indicators)

(1) Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM
(2) Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM

2) Project Purpose

More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.

(Objectively Verifiable Indicators)

(1) Traceability of meteorology instruments (Availability of national standards/frequency of inspection)
(2) Number of missing observation data
(3) Accuracy of rainfall forecast in the selected stations.
(4) Number of selected station where weekly forecast is enabled in trial basis

3) Expected Outputs and Objectively Verifiable Indicators

Outputs 1: Capacity on maintenance and calibration of meteorological observation equipment is improved

(Objectively Verifiable Indicators)

1-1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project.
1-2 Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff.

Outputs 2: Transmitting and receiving capacity of various kinds of meteorological data is strengthened.

(Objectively Verifiable Indicators)

2-1 Data from AWS are obtained and made available to a full extent in DOM.

2-2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project.

Outputs 3: Capacity of weather forecasting is improved using obtained meteorological data.

(Objectively Verifiable Indicators)

3-1 At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance.

3-2 At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind.

Outputs 4: Warning criteria is elaborated.

(Objectively Verifiable Indicators)

4-1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared.

Outputs 5: The method of dissemination and contents of meteorological information are improved.

(Objectively Verifiable Indicators)

5-1 Number of developed educational material for weather services.

5-2 Monthly access number of the DOM Website is increased by 30% or more. The objectives of the Project are as follows.

2. Actual Inputs

2-1 Dispatch of JICA Expert

(1) The following JICA experts of Consultant Team that were involved in the Project for three (3) years in accordance with the following schedule. After that, the Expert Dispatch Schedule, the Flowchart, and the Work Schedule are shown in order.

Table 2: Dispatch of JICA Expert (Consultant Team)

Field	Name of Experts	Project Phase	Dispatch Record	In Sri Lanka	In Japan
Leader/Weather Forecasting	Yoshihisa UCHIDA	Phase 1	Sep. 29, 2014 - Oct. 16, 2014 Jan. 15, 2015 - Feb. 02, 2015 Jun. 20, 2015 - Jul. 12, 2015	2.00 M/M	0.30 M/M
		Phase 2	Dec. 01, 2015 - Dec. 21, 2015 Apr. 21, 2016 - May 11, 2016 Jun. 05, 2016 - Jul. 04, 2016 Oct. 31, 2016 - Nov. 21, 2016 Mar. 24, 2017 - Apr. 09, 2017 Apr. 28, 2017 - May. 03, 2017 Jul. 19, 2017 - Jul. 25, 2017	4.20 M/M	0.35 M/M
Weather Guidance	Nobutaka NOGUCHI	Phase 1	Sep. 29, 2014 - Oct. 16, 2014 Jan. 15, 2015 - Feb. 02, 2015 Jun. 20, 2015 - Jul. 12, 2015	2.00 M/M	0.45 M/M
		Phase 2	Dec. 01, 2015 - Dec. 21, 2015 Apr. 21, 2016 - May 11, 2016 Jun. 14, 2016 - Jul. 04, 2016 Nov. 01, 2016 - Nov. 21, 2016 Mar. 10, 2017 - Apr. 09, 2017 Apr. 26, 2017 - May. 03, 2017 Jul. 18, 2017 - Jul. 27, 2017	4.43 M/M	0.60 M/M
Meteorological Observation Technology	Toshihide ENDO	Phase 1	Sep. 29, 2014 - Oct. 16, 2014 Jan. 12, 2015 - Feb. 02, 2015 Jun. 14, 2015 - Jul. 04, 2015	2.00 M/M	0.25 M/M
		Phase 2	Dec. 01, 2015 - Dec. 21, 2015 Apr. 21, 2016 - May 11, 2016 Jun. 30, 2016 - Jul. 17, 2016 Oct. 29, 2016 - Nov. 21, 2016 Mar. 10, 2017 - Apr. 09, 2017 Apr. 26, 2017 - May. 03, 2017	4.47 M/M	0.20 M/M

			Jul. 18, 2017 Jul. 28, 2017		
Data Management/ Information Technology	Takanari FUJII	Phase 1	Oct. 01, 2014 - Oct. 18, 2014 Jan. 21, 2015 - Feb. 10, 2015 Jun. 21, 2015 - Jul. 11, 2015	2.00 M/M	0.10 M/M
		Phase 2	Jun. 22, 2016 Jul. 12, 2016 Oct. 31, 2016 Nov. 19, 2016 Feb. 19, 2017 - Mar. 03, 2017 Mar. 24, 2017 - Apr. 05, 2017 May 14, 2017 May 27, 2017	2.70 M/M	0.15 M/M
Weather Information Dissemination	Soshi IWATA	Phase 1	Sep. 29, 2014 - Oct. 16, 2014 Apr. 05, 2015 - Apr. 25, 2015 Jun. 21, 2015 - Jul. 11, 2015	2.00 M/M	0.25 M/M
		Phase 2	Dec. 01, 2015 Dec. 18, 2015 Jun. 09, 2016 Jul. 02, 2016 Oct. 25, 2016 - Nov. 19, 2016 Mar. 01, 2017 - Mar. 15, 2017 May 16, 2017 Jun. 02, 2017	3.60 M/M	0.85 M/M
Website	Satoko NEGORO	Phase 1	Apr. 05, 2015 - Apr. 25, 2015 Jun. 21, 2015 - Jul. 11, 2015	1.40 M/M	0.10 M/M
	Motohiro YAMAUCHI	Phase 2	Dec. 01, 2015 - Dec. 21, 2015 Apr. 21, 2016 - May 11, 2016 Jun. 05, 2016 - Jul. 04, 2016 Oct. 29, 2016 - Nov. 21, 2016	3.20 M/M	0.15 M/M
Project Coordinator/Weather Forecasting Assistant	<Sri Lanka> Rashid Uz ZAMAN	Phase 1	Apr. 05, 2015 - Apr. 19, 2015	0.50 M/M	-
		Phase 2	Jun. 07, 2016 - Jun. 25, 2016 Oct. 25, 2016 - Nov. 12, 2016	1.00 M/M (0.27MM)	-
	<Japan> Kumiko MURAKAMI	Phase 2	- -	-	2.60 M/M

*: Consultant self payment

(2) The JICA long term expert was dispatched during the project as indicated in Table 3.

Table 3: Dispatch of JICA Expert (Long Term Expert)

Field	Name of Expert	Contract Phase	Dispatch Record
Chef Technical Advisor	Masahito ISHIHARA	Phase 1	Sep. 22, 2014 - Sep. 19, 2016
		Phase 2	Sep. 20, 2016 - Sep. 17, 2014

(2) The JICA short term experts were dispatched as shown in Table 4.

Table 4: Dispatch of JICA Expert (Short Term Expert)

Training Course	Name	Position	Period (Number of trainees)	Goal
Theoretical Tropical Meteorology	Dr. Manabu Yamanaka	JAMSTEC	21 Nov. to 2 Dec. 2016 (14)	Acquiring knowledge on theoretical meteorology in the tropics
Meteorological Instrument Calibration 1	Mr. Sadanori ARAKAKI Mr. Satoshi HAGIYA	RIC-Tsukuba, JMA	13 to 20 Jan. 2017 (24)	Acquiring the technique to establish the instrument traceability
Operational Tropical Meteorology	Mr. Atsushi GOTO	Global Environment and Marine Department, JMA	23 to 27 Jan. 2017 (33)	Acquiring the operational technique to make analysis of tropical weather using JRA55 and iTacs
Upper-air Observation	Mr. Toshihiro ABO	Aerological Observatory, JMA	2 to 7 June 2017 (22)	Acquiring the latest technology of upper-air observation and discussing improvement of the current situation of DOM
Meteorological Instrument Calibration 2	Mr. Sadanori ARAKAKI Mr. Satoshi HAGIYA	RIC-Tsukuba, JMA	12 to 16 June 2017 (21)	Acquiring technology to complete the instrument traceability
Quantitative Precipitation Estimation (QPE)	Dr. Ahoro ADACHI	Meteorological Research Institute, JMA	24 to 26 July 2017 (18)	Learning fundamental and application of dual polarization weather radars and QFE technique using the radar data
Quantitative Precipitation Forecast (QPF)	Mr. Kazuhiko NAGATA	Forecast Department JMA	24 to 26 July 2017 (18)	Learning QPF technique necessary for producing information to make forecast of flooding and landslide disaster
Satellite Animation and	Mr. Junya FUKUDA	Forecast Department	21 to 26 Aug. 2017	Acquiring the skill to make weather analysis using

Interactive Diagnosis (SATAID)	Mr. Takumi MARUYAMA	JMA Meteorological Satellite Center JMA	(15)	satellite and NWP data obtained from the Himawari-cast Receiving Receiver with SATAID Program

(4) Counter parts of the project

27 staff members of the DOM were selected as counter parts of the project at the kick-off meeting held in September 2014. At the first JCC in October 2014, Mr. Chandrapara (Director General), Mr. Premalal (Director) and Mr. Jayasinghearachchi (Director) were assigned to the project direct, the project manager and the project assistant-manager in the project, respectively.

2-1-1 Expert Dispatch Schedule

	No.	Field	Name	Company	Rank		Phase 1 Man-Month Sri Lanka	Phase 1 Man-Month Japan	Phase 2 Man-Month Sri Lanka	Phase 2 Man-Month Japan	Total Man-Month Sri Lanka	Total Man-Month Japan
Activity in Sri Lanka	1	Leader / Weather Forecasting	Yoshihisa UCHIDA	IMC	2	Original Plan	2.00	-	4.30	-	6.30	-
						Mobilized	2.00	-	4.20	-	6.20	-
	2	Weather Guidance	Nobutaka NOGUCHI	IMC	3	Original Plan	2.00	-	4.50	-	6.50	-
						Mobilized	2.00	-	4.43	-	6.43	-
	3	Meteorological Observation Technology	Toshihide ENDO	IMC	3	Original Plan	2.00	-	4.00	-	6.00	-
						Mobilized	2.00	-	4.07	-	6.07	-
					4	Original Plan	0.00	-	0.00	-	0.00	-
						Mobilized	0.00	-	0.40	-	0.40	-
	4	Data Management / Information Technology	Takanari FUJII	JWA	3	Original Plan	2.00	-	2.70	-	4.70	-
						Mobilized	2.00	-	2.70	-	4.70	-
	5	Weather Information Dissemination	Soshi IWATA	JWA	3	Original Plan	2.00	-	3.60	-	5.60	-
						Mobilized	2.00	-	3.60	-	5.60	-
	6	Website	Satoko NEGORO Motohiro YAMAUCHI	IMC	4	Original Plan	1.40	-	3.80	-	5.20	-
						Mobilized	1.40	-	3.20	-	4.60	-
	7	Project Coordinator / Weather Forecasting Assistant	Rashid ZAMAN	IMC	5	Original Plan	0.50	-	1.00	-	1.50	-
						Mobilized	0.50	-	1.00	-	1.50	-
						Original Plan Man-Month Total	**11.90**	**-**	**23.90**	**-**	**35.80**	**-**
						Mobilized Total	**11.90**	**-**	**23.60**	**-**	**35.50**	**-**
Activity in Japan	1	Leader / Weather Forecasting	***	IMC	2	Original Plan	-	0.30	-	0.35	-	0.65
						Mobilized	-	0.30	-	0.45	-	0.75
	2	Weather Guidance	***	IMC	3	Original Plan	-	0.45	-	0.60	-	1.05
						Mobilized	-	0.45	-	0.60	-	1.05
	3	Meteorological Observation Technology	***	IMC	3	Original Plan	-	0.25	-	0.20	-	0.45
						Mobilized	-	0.25	-	0.20	-	0.45
	4	Data Management / Information Technology	***	JWA	3	Original Plan	-	0.10	-	0.15	-	0.25
						Mobilized	-	0.10	-	0.15	-	0.25
	5	Weather Information Dissemination	***	JWA	3	Original Plan	-	0.25	-	0.85	-	1.10
						Mobilized	-	0.25	-	0.85	-	1.10
	6	Website	***	IMC	4	Original Plan	-	0.10	-	0.15	-	0.25
						Mobilized	-	0.10	-	0.35	-	0.45
	7	Project Coordinator / Weather Forecasting Assistant	***	IMC	5	Original Plan	-	0.00	-	2.60	-	2.60
						Mobilized	-	0.00	-	2.60	-	2.60
						Original Plan Man-Month Total	**-**	**1.45**	**-**	**4.90**	**-**	**6.35**
						Mobilized Total	**-**	**1.45**	**-**	**5.20**	**-**	**6.65**

Phase 1: 2014 9 10 11 12 / 2015 1 2 3 4 5 6 7 8 — Phase 2: 2015 9 10 11 12 / 2016 1 2 3 4 5 6 7 8 9 10 11 12 / 2017 1 2 3 4 5 6 7 8 9

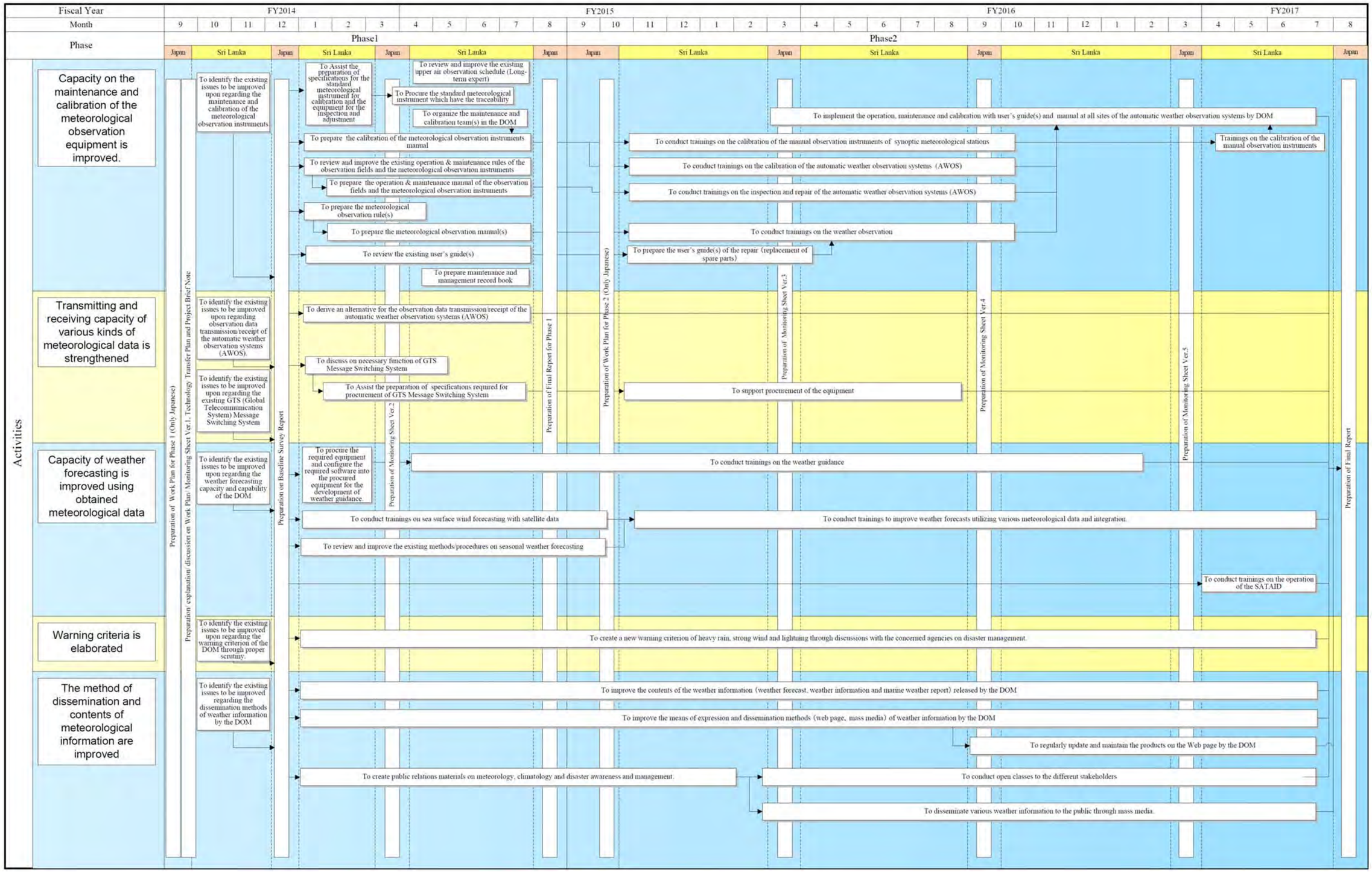
Report	Submission Schedule
G/R1 W/P	△
B/R	△
M/S2	△
F/R1	△
G/R2	△
M/S3	△
M/S4	△
M/S5	△
F/R2	△

Legend ■ : Activity in Sri Lanka
□ : Activity in Japan

IMC: International Meteorological Consultant Inc.
JWA: Japan Weather Association

*Type of Report
- G/R1 : Work Plan (Japanese)
- W/P : Work Plan (Phase1)／Monitoring Sheet Ver.1
- B/R : Baseline Survey Report
- M/S2 : Monitoring Sheet Ver. 2
- F/R1 : Project Completion Report (Phase1)
- G/R2 : Work Plan (Phase2)
- M/S3 : Monitoring Sheet Ver. 3
- M/S4 : Monitoring Sheet Ver. 4
- M/S5 : Monitoring Sheet Ver. 5
- F/R2 : Project Completion Report (Phase1)

2-1-2 Flowchart



2-1-3 Work Schedule

	Phase1												Phase2																								
	2014							2015												2016												2017					
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Baseline Survey: Capacity Assessment in Sri Lanka																																					
Understanding of the maintenance and management conditions of the meteorological observation equipment and the maintenance and management capability of the staff		■																																			
Current situation of the observation data transmission between the AWS sites and the DOM headquarters		■																																			
Understanding of the current condition of the GTS message switching system		■																																			
Evaluation of staff capability concerning meteorological forecasting		■																																			
Evaluation of staff capability concerning the dissemination of meteorological information (including educational activities) and communication technology		■																																			
Capacity on maintenance and calibration of meteorological observation equipment is improved.																																					
To review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved.		■			■																																
To procure the necessary instruments for calibration of meteorological equipment, and establish teams for proper maintenance and calibration.					■						■																										
To establish the traceability of meteorological instruments.	<Long-term expert's activity>																																				
To conduct training on calibration of conventional and AWS equipment	<Short-term expert's activity>										■					■					■		■				■				■		■				
To review and revise the Standard Operation Procedure for manual and AWS observation.					■						■					■					■																
To review and revise inspection and repairing (parts replacing) user's guide(s) for AWS											■					■					■																
To conduct trainings on the inspection and repairing of AWS											■					■					■		■				■				■		■				
To review the upper air observation schedule.	<Long-term expert's activity>																																				
Transmitting and receiving capacity of various kinds of meteorological data is strengthened.																																					
To review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved.		■			■																																
To examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.					■						■					■					■						■				■		■				
To review the current situation on GTS/MSS, and identify the issues to be improved.		■			■																																
To replace and upgrade the GTS/MSS.					■						■					■					■						■				■		■				
Capacity of weather forecasting is improved using obtained meteorological data																																					
To review the current situation on the weather forecasting and identify the issues to be improved.		■			■																																
To conduct the training on the development of Short Range and Weekly (7 days ahead) Weather Forecast Guidance and verification.					■																																
To produce Short Range and Weekly (7 days ahead) Weather Forecast Guidance at the selected stations.											■					■					■	■					■				■	■	■				
To produce Weather Forecast Guidance of Sea Wind at the selected stations.					■																	■					■										
To conduct the trainings on Satellite Animation and Interactive Diagnosis (SATAID)	<Short-term expert's activity>																																				
To review and improve the existing methods of seasonal precipitation forecast.					■						■					■					■	■					■				■	■	■				
To conduct on-the-job training on improvement of weather forecasting operation through integration of various data.											■					■					■	■					■				■	■	■				
Warning criteria is elaborated																																					
To review the current situation on warnings, and identify the areas to be improved.		■				■																															
To examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning.						■					■												■				■			■		■	■				
The method of dissemination and contents of meteorological information are improved.																																					
To review the contents of current meteorological information, and identify the issues to be improved.		■						■																													
To improve the contents of weather information.								■			■					■			■		■	■					■										
To review the timing of information dissemination to ships and fleet											■					■			■																		
To improve the contents of Website.								■			■					■			■		■	■															
To prepare smartphone compatible Website								■			■					■			■		■	■					■										
To conduct the training on responses to the mass media																						■					■										
To regularly update and maintain the products on the Website by the DOM.																						■					■										
To provide the rainings on update of the contents																						■					■					■					
To prepare the update operation manual for the products on the web pages																					■	■															
To prepare educational material (disaster awareness materials) for the weather services.		■						■			■					■			■			■					■					■	■				
To conduct open classes																																■	■			■	
Annual seminar																																			■		
Training in Japan																		▒	▒											▒	▒						

2-2 Provision of Equipment

(1) The Equipment procured by the Consultant for the activities of each expert and provided to the DOM under the Project is listed in the following table.

Table 5: List of Equipment Provided Under the Project (Procured by Consultant Team)

No.	Name of Equipment	Manufacturer	Model	Purpose	Q'ty	Installation Place	Procurement Date
Phase 1							
1	Wireless Router	D-Link	DWR-113	For Internet Access (Forecasting Room)	1	DOM Head Office	October 04, 2014
2	Laminator (A3)	BIOSYSTEM	SOUL 330C	For the distribution of Weather Information Dissemination Products	1	DOM Head Office	January 15, 2015
3	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	2	DOM Head Office	January 16, 2015
4	Laptop PC for Establishment of Website	DELL	Inspiron 5000 (17inch)	For the conduct of the Training for Website creation and maintenance	1	DOM Head Office	January 16, 2015
5	Laptop PC for Conduct of Training on, Weather Guidance	DELL	Inspiron 5000 (15inch)	For the conduct of Training on Weather Guidance	7	DOM Head Office	January 17, 2015
6	Laptop PC for the Download of Observation Data	DELL	Inspiron 5000 (15inch)	For the distribution of Weather Information Dissemination Products	1	DOM Head Office	January 17, 2015
7	Monitor for Weather Briefing	SHARP, etc.	SHPLC60LE650, etc.	For the conduct of Weather Briefing	1	DOM Head Office	January 19, 2015

8	Additional Lightning Protection System	-	-	For the strengthening of the AWS Lightning Protection	3	Polonnarumwa, Aralaganwill and Ratnapura Observation Stations	January 30, 2015
9	Multifunction Machine (Printer/Photocopy)	CANON	IR2545	For the copy and printing of Training Material and Products	1	DOM Head Office	March 13, 2015
10	Website Template Program	JB TECH ENGINEERING	Joomla 3.4 Compatible	For the production of the Website	1	DOM Head Office	June 21, 2015
11	Spare Parts for the AWS - Data Logger - Wind Direction and Speed Sensor - Temperature Sensor - Rain Gauge - Pressure Sensor - Hygrometer - Cap for Humidity Transmitter - Solar Radiation Sensor	 MEISEI VAISALA MEISEI MEISEI VAISALA VAISALA VAISALA EKO	 113115-001 WMT-700 , MES-39457 MES-39459 PTB-330A HMT-333 DRW010281SP MS402	For the maintenance of the AWS	 2 4 1 1 1 1 10 1	DOM Head Office	July 8, 2015
12	Standard Meteorological Instrument (Electric Temperature Sensor)	CHINO	CAB-F201-2, R900-F25AD	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015
13	Standard Meteorological Instrument (Electric Pressure Sensor)	VAISALA	PTB330TS, M170	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015

14	Portable Calibration System (Portable AWS)	VAISALA, DELAIRCO, etc.	PTB330A, DLM, etc.	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015
Phase 2							
15	Laser Pointer	KOKUYO	ELP-G10	For Training and Open Class	1	DOM Head Office	December 1, 2015
16	Sound System for Open Class	YAMAHA, ELECTRO VOICE, etc.	Stagepass 400i, etc.	For Open Class	1	DOM Head Office	December 14, 2015
17	Projector with Screen for Open Class	EPSON, etc.	EB-W04, etc.	For Open Class	1	DOM Head Office	May 07, 2016
18	Cooler Box	LION STAR	22L	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 2, 2016
19	Extension Power Code	CABLE REEL	30m	For Open Class	1	DOM Head Office	July 4, 2016
20	Ice Shaving Machine	CHUBU CORPORATION	Hatsuyuki HA-110S	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
21	Thermometer Inspection Bath	THOMAS KAGAKU	Celsius 100L	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
22	Barometer Calibration Device	DAIICHI KAGAKU	112704878-004-1	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
23	Spare Parts for the AWS - Data Logger - Temperature Sensor - Rain Gauge - Pressure Sensor - Hygrometer - Cap for Humidity	 MEISEI MEISEI OGASAWARA VAISALA MEISEI VAISALA	 113115-001 MES-39457 RS-102N1 PTB-330A MES-39458 DRW010281SP	For the maintenance of the AWS	 2 3 3 3 3 10	DOM Head Office	July 22, 2016

	Transmitter - Solar Radiation Sensor - Surge Arrester for Power - Surge Arrester for LAN - GPS Antenna for Data Logger	 EKO MORINAGA SANKO POSITION	 MS402 ALPK-VNJ2P LAN-100IS GA-08R (3M) BNC		 3 2 2 2		
24	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	1	DOM Head Office	November 05, 2016
25	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	1	DOM Head Office	November 11, 2016
26	Hard Disk (4T)	Western Digital Corporation (WD)	MY PASSPORT	For the WRF Data Storage	1	DOM Head Office	April 06, 2017
27	Projector Stand	Shonzon Screen Works	Portable Tripod Projector	To set a projector at appropriate place promptly	1	DOM Head Office	May 29, 2017

(2) The Equipment procured by the Long-term Expert and provided to the DOM under the Project is listed in the following table.

Table 6: Lists of Equipment Provided Under the Project（Procured by Long Term Expert）

No.	Name of Equipment	Manufacturer	Model	Purpose	Q ' t y	Installation Place	Procurement Date
1	Camera	Nikon	D3300 Camera with 18-55mm VR II Lens	For the recording of project activities	1	DOM Head Office	January 7, 2015

2	Laptop computer	HP	Pavilion 15-P022tu Core i3-4030U Notebook	For the production of training documents	1	DOM Head Office	January 16, 2015
3	Multi-function Printer	Canon	iC MF 8580 CDW Multi-function Machine	For the printing training documents	1	DOM Head Office	February 5, 2015
4	Projector	Epson	Epson Multi- Media Projector	For the projecting training materials	1	DOM Head Office	March 12, 2015
5	Vehicle	Toyota	Hilux 4WD Double Cab including canopy	For the of survey of regional offices of DOM	1	DOM Head Office	March 31, 2015
6	GPS Receiver	Garmin	GPS eTrex 30	For the survey of identifying latitudes and longitudes of meteorological instruments	1	DOM Head Office	October 15, 2015
7	Freezer	Candy	Chest Freezer	For the producing ice to make freezing point calibration of thermometers	1	DOM Head Office	June 21, 2015
8	Air conditioner	Panasonic	S24RKH%6938905 133	For the air conditioning of the training center of DOM	2	DOM Head Office	August 11, 2016
9	Air conditioner	Panasonic	S24RKH%6938905 133	For the air conditioning of the training center of DOM	2	DOM Head Office	December 12, 2016
10	Digital Barometer	Vaisala	PTB330TS & Indicator M170	For the sub-standard of pressure	1	DOM Head Office	March 17, 2017

11	Printer	Canon	ImageCLASS LBP-8100n	For the printing weather charts to be connected with the GTS/MSS terminal	1	DOM Head Office	August 18, 2017

(3) The Equipment procured by JICA and provided to the DOM under the Project is listed in the following table.

Table7 : List of Equipment Provided Under the Project (Procured by JICA)

No.	Name of Equipment	Manufacturer	Model	Purpose	Q'ty	Installation Place	Procurement Date
1	GTS Message Switch System	ESS Weathertech Pty Ltd.	GTS Message Switch System	For the Exchange of Meteorological Information	1	DOM Head Office, Colombo International Airport and Mattala Rajapaksa International Airport	December 18, 2015
2	HimawariCast Reception System	Delairco Japan KK	HimawariCast Reception System	For receiving the Himawari-8 data	1	DOM Head Office and Colombo International Airport	August 16, 2017

2-3 List of the Project Documents

The documents submitted to the DOM and the JICA are listed in the following table.

Table 8: List of the Project Documents

Project Phase	Documents submitted to the DOM and the JICA	Submission
Phase 1	Work Plan of Phase 1 (Japanese)	September, 2014
	Work Plan /Monitoring Sheet Ver.1	October, 2014
	Brief Note	December, 2014
	Baseline Report	December, 2014
	Monitoring Sheet Ver.2	April, 2015
	Final Report of Phase 1	August, 2015
Phase 2	Work Plan of Phase 2 (Japanese)	October, 2015
	Monitoring Sheet Ver.3	April, 2016
	Monitoring Sheet Ver.4	September, 2016
	Monitoring Sheet Ver.5	March, 2017
	Brief Note (Final Version)	August, 2017
	Final Report of the Project	August, 2017

2-4 List of the Project Outputs

(1) The Project Outputs prepared by the Consultant Team under the Project are listed in the following table.

Table 9: List of the Project Outputs (Consultant Team)

PDM Output	Project Output prepared the Consultant Team under the Project
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	■ All the required documents necessary for the procurement process including the technical specifications for the new instruments for the calibration of meteorological equipment. ■ Construction of an additional lightning protection pole needed at three particular sites (Polonnaruwa, Aralagatonwila and Ratnapura) vulnerable to lightning strikes. ■ Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System

	■ Preventive Maintenance Record for Automatic Weather Observation System ■ Basic Troubleshooting and Inspection Procedure for Automatic Weather Observation System ■ Spare Parts (Sensor) Replacement Procedure for Recovery of Automatic Weather Observation System ■ Observation Guidelines of Manual Observation by Observation Instrument ■ Portable Automatic Weather Station Operation Manual
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	■ All the required documents necessary for the procurement process including the technical specifications for new Global Telecommunication System/Message Switching System (GTS/MSS) equipment. ■ Network Diagram of the before and after scenario on the change of the system network which utilized the IP-VPN ■ Flowchart for the smooth transition from the current VSAT system to the IP-VPN system.
3. Capacity of weather forecasting is improved using obtained meteorological data.	■ Excel Files for Weather Guidance Training ■ Lists of Predictors Group for Weather Guidance ■ Formula in Excel ■ Observation Data Circulation ■ Excel Database for WRF of DOM, Sri Lanka ■ Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the year. ■ Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the First Intern-Monsoon Season ■ Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Southwest Monsoon Season ■ Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Northeast Monsoon Season

	■ Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Second Intern-Monsoon Season ■ Weekly (144h-168h) Weather Forecast Guidance (Colombo and Ratnapura) for Precipitation with the GFS (NOAA Global Forecast System) Grid Point Vale of 0.5 degree mesh data ■ Weekly (144h-168h) Weather Forecast Guidance (Colombo and Ratnapura) for Precipitation with the GFS (NOAA Global Forecast System) Grid Point Vale of 0.5 degree mesh data ■ Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale ■ Short Range (Puttalam and Pottuvil: 24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance with the DOM WRF Grid Point Vale ■ Seasonal Weather Forecast Guidance for Precipitation (by 2040) with sea surface temperature observation data at 5 selected points in Pacific, Indian and Atlantic Oceans and rainfall observation data of Colombo for 36 years with the CFS (NOAA Climate Forecast System) Grid Point Vale
4. Warning criteria is elaborated.	■ Explanatory material of analysis procedures for Heavy Rain Advisory and Warning ■ Explanatory material of analysis procedures for Strong Wind Advisory and Warning ■ Explanatory material of analysis procedures for Lightning Advisory ■ Master file of DOM new warning bulletin (Color version) ■ Master file of DOM new warning bulletin (Monochrome version) ■ Analytical results of Heavy Rain Advisory and Warning ■ Analytical results of Strong Wind Advisory and Warning ■ Analytical results of Lightning Advisory ■ Analytical data of Heavy Rain Advisory and Warning ■ Analytical data of Strong Wind Advisory and Warning ■ Analytical data of Lightning Advisory
5. The method of dissemination and	■ Visual flow chart of the current website flow chart ■ Visual flow chart of the future website flow chart

contents of meteorological information are improved.	■ Story Plot of the animation ■ Animated cartoon "Save Yourself" (EP1: Climate of Sri Lanka, EP2: Thunderstorm and Lightning, EP3: Heavy Rain and Disaster, English/Sinhala/Tamil, MP4(HD) format) ■ Laminated "Beaufort Scale on Land" (English/Sinhala/Tamil) ■ Laminated "Beaufort Scale at Sea" (English/Sinhala/Tamil) ■ DOM rubber mascot ■ Text book for "Drawing Graphics by PowerPoint" ■ Comprehension test conducted in Open Class (English/Sinhala/Tamil) ■ Results of Open Classes ■ Major Dissemination Activities ■ Cloud Types for Observers in Sri Lanka

(2) The Project Outputs prepared by the Long-term Expert and the Short-term Experts under the Project are listed in the following table.

Table 10: List of the Project Outputs (the Long-term Expert and the Short-term Experts)

PDM Outputs	Project outputs prepared by the Long-term Expert and the short-term Experts
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	■ DOM Instrument Calibration Improvement Plan ■ DOM Guideline to the Meteorological Instrument Inspection ■ DOM Manuals for Meteorological Instrument Inspection ■ Review on the Upper-air Observation of the DOM by the Long-term Expert ■ Report on the Short-term Expert Training "Upper-air Observation" ■ Observation manual on the GPS Radiosonde iMS-100 by the Short-term Expert ■ Documents in the Short-term Experts Training "Meteorological Instrument Calibration 1" ■ Documents of the Short-term Experts Training "Meteorological Instrument Calibration 2" ■ Documents of the C/P Training Program "Meteorological Instrument Calibration" ■ Documents of the C/P Training Program "Meteorological Observation"

3. Capacity of weather forecasting is improved using obtained meteorological data.	■ Lecture note of the lecture ”Basic Meteorology” by the Long-term Expert ■ Documents of the Short-term Expert Training “Theoretical Tropical Meteorology” ■ Documents of the Short-term Expert Training “Operational Tropical Meteorology” ■ Documents of the Short-term Expert Training “Quantitative Precipitation Estimation: QPE” ■ Documents of the Short-term Expert Training “Quantitative Precipitation Forecast: QPF”
Others (Advices and reports produced by the Long-term Expert and submitted to the DOM)	■ Report on the survey to select sites for installation of weather radars ■ Note on the Gongala radar site visit ■ Report on the Riverston radar proposed site visit (in Japanese) ■ Issues in the medium-term master plan of weather services in Sri Lanka ■ Report on the current situation of the AWS data loggers and proposed measure ■ Report on the business trip of the survey on the current situation of the DOM Manner Regional Office (in Japanese) ■ Report on the weather situation at the Koslanda landslide on October 29, 2014 ■ Report on the survey on the Kadowata tornado damage on 7 January 2016 ■ Report on the Weather Situation at the Rainfall Disasters due to Tropical Depression B-01 (Cyclone Roanu） in May 2016 ■ Report on the current situation of the drought in Sri Lanka ■ Report on the weather summary on the heavy rainfall disaster on 25 May 2017 ■ Weather Project News Letter Vol.2 ■ Documents on the Weather Disaster Seminar on 25 July 2017

2-5 Counterpart Trainings in Japan

(1) JICA C/P Training Programs arranged by the Consultant Team

<Name of the Counterpart Trainings>

First Training: Weather Forecasting & Weather Information Dissemination

Second Training: Weather Forecasting

<Participating Trainees>

4 personnel from the Operational Weather Forecasters of the Department of Meteorology (DOM), Sri Lanka.

< Training Contents and Schedule>

- First Training

Table 11: Summary of the First Training

Course Period	February 29, 2016 to March 15, 2016 (16 days)
Participants	1. Mr. JAYASEKERA Siri Ranjith (Director of Forecasting & Decision Support) 2. Mr. KARUNANAYAKE Athula Kumara (Deputy Director, Training Division) 3. Ms. JAYAKODY Preethika Madhavi (Meteorologist) 4. Mr. PEIRIS Thammahetti Mudalige Nandalal (Meteorologist)
Training Venues	JICA Chubu International Center (Nagoya), Gifu University, Nippon Television Network, Inc., and Life Safety Learning Center, Tokyo Fire Department, Japan Meteorological Agency (Otemachi), JICA Tokyo International Center (Hatagaya).
Training Contents	1. Learning the principles of the local meteorological forecast model and sea wave forecast model. 2. Understanding of the meteorology of turbulent flow in the surface boundary layer. 3. Understanding of the heat budget of meteorological phenomena and of the human body.

	4. Understanding atmospheric pressure patterns and local meteorology as well as learning the classification method of atmospheric pressure patterns. 5. Weather Information Dissemination

Table 12: First Training Schedule

Date		Training Contents	Training Venues
1	28 February (Sun)	Colombo → Chubu Centrair International Airport, Nagoya	
2	29 February (Mon)	Orientation Briefing	JICA Chubu International Center (Nagoya)
3	01 March (Tue)	Local meteorological forecast model 1	Gifu University
4	02 March (Wed)	Local meteorological forecast model 1	Gifu University
5	03 March (Thu)	Sea wave forecast model	Gifu University
6	04 March (Fri)	Meteorology of surface boundary layer and turbulent flow	Gifu University
7	05 March (Sat)	Holiday (Excursion to heavy snowfall area: Shirakawago)	
8	06 March (Sun)	Holiday	
9	07 March (Mon)	Utilization of renewable energy (wind-power and solar power generation)	Gifu University
10	08 March (Tue)	Heat budget of meteorological phenomena and human body	Gifu University
11	09 March (Wed)	Local meteorology in Japan 1	Gifu University
12	10 March (Thu)	Local meteorology in Japan 2	Gifu University
13	11 March (Fri)	Classification of pressure pattern and regional meteorology (work study)	Gifu University
14	12 March (Sat)	Gifu →Tokyo	
15	13 March	Holiday	

	(Sun)		
16	14 March (Mon)	Disaster experience learning center such as heavy rain and earthquake.	Life Safety Learning Center, Tokyo Fire Department (Oshiage)
		Weather information provision service by a commercial private broadcasting station	Nippon Television Network, Co. (Shinbashi)
17	15 March (Tue)	Courtesy call	Japan Meteorological Agency (Otemachi)
		JICA Evaluation Meeting	JICA Tokyo International Center (Hatagaya)
18	16 March (Wed)	Narita → Colombo	

- Second Training

Table 13: Summary of the Second Training

Course Period	March 9, 2017 to March 23, 2017 (15 days)
Participants	1. Ms. WARNASOORIYA Anusha Rashanthi Patabedi (Deputy Director) 2. Mr. RATHUGAMAGE Malith Prasanna Fernando (Meteorologist) 3. Mr. PREMATHILAKE Jayasinghe Sepalage D. S. (Meteorologist) 4. Mr. KUMARA Athdath Waduge Susantha Janaka (Meteorologist)
Training Venues	JICA Chubu International Center (Nagoya), Gifu University in Japan, Tsukuba University in Japan, Japan Meteorological Agency (Otemachi), JICA Tokyo International Center (Hatagaya)
Training Contents	1. Learning the WRF (Weather Research and Forecasting) model and WRF Data Assimilation System (WRFDA) 2. Practice on the operation and tuning of the WRF model and WRFDA

Table 14: Second Training Schedule

Date		Training Contents	Training Venues
1	07 March (Tue)	Colombo →	
2	08 March (Wed)	→ Chubu Centrair International Airport, Nagoya	

3	9 March (Thu)	JICA Orientation Briefing	JICA Chubu International Center (Nagoya)
4	10 March (Fri)	Installation and Operation check of Linux and WRF	Gifu University
5	11 March (Sat)	Holiday	
6	12 March (Sun)	Holiday	
7	13 March (Mon)	Set up and Practical Run of WRF	Gifu University
8	14 March (Tue)	Sea Wave Forecast Model	Gifu University
9	15 March (Wed)	Drawing and Analyzing Output from WRF Model	Gifu University
10	16 March (Thu)	Local Climate Change in South East Asia Gifu → Takayama	Gifu University
11	17 March (Fri)	Highland Meteorological Observation and Data Acquisition Takayama → Gifu	Gifu University Takayama Observation Station
12	18 March (Sat)	Gifu → Tokyo →Tsukuba	
13	19 March (Sun)	Holiday	
14	20 March (Mon)	Understanding the WRFDA	Tsukuba University
15	21 March (Tue)	Set up and Practical Run of the WRFDA	Tsukuba University
16	22 March (Wed)	Evaluation of the WRFDA Practical Run and Tune-up Method	Tsukuba University
17	23 March (Thu)	Tsukuba → Tokyo Courtesy call	Japan Meteorological Agency (Otemachi)
		JICA Evaluation Meeting	JICA Tokyo International Center (Hatagaya)
18	24 March (Fri)	Narita → Colombo	

(2) JICA C/P Training Programs arranged by the JICA HQs and the Long-term Expert

<Name of the Counterpart Training>

The 1st Program: Meteorological Instrument Calibration

The 2nd Program: Meteorological Observation

<Participating Trainees>

The 1st program: Staff in charge of meteorological instruments and electronics engineering of the DOM

The 2nd Program: Staff in charge of meteorological observations of the DOM

< Training Contents and Schedule>

- The 1st training Program

  Four staff of the DOM instrument division and the electronic division were trained in RIC-Tsukuba of JMA during two weeks in February 2016 in order to obtain the technique of meteorological instrument calibration as an unit of the activities 1.3 in the project "Establish the traceability of meteorological instrument" (Photo 2-1). Coupled with the short-term expert training courses in DOM, 'Meteorological Instrument Calibration 1' and 'Meteorological Instrument Calibration 2', the staff of the instrument division of DOM have obtained the full technique to make calibration of pressure and temperature instruments by themselves, and have started the new instrument calibration scheme in DOM.

  The contents of the 1st training are summarized in the following Table.

Table 15: Summary of the 1st C/P Training Program

Meteorological Instrument Calibration		
Outline of the training	Training Period	February 8, 2016 to February 19, 2016（12 days）
	Training Venues	Meteorological Instrument Center, JMA (RIC-Tsukuba) Head Quarters, JMA Tokyo Regional Headquarter, JMA
	Participants	■ Ms. WEERAPPERUMAGE DONA Liliyan Malani (Meteorological Officer in charge, Instrument Division) ■ Mr. METTASINGHE Napagoda Achchillage

		(Meteorological Officer Class, Instrument Division) ■ Mr. PRIYADHARSENA Wannakuwattawaduge Prasanna Kelum (Electronic Engineering, Electronic Engineering Division) ■ Mr. HATHTHOTUWA GAMAGE Prasanna Ranga Kumara (Telecommunication & Radar Technical Officer, Electronic Engineering Division)
Training purposes	1. Learning the techniques of meteorological instrument calibration 2. Acquiring information on meteorological observations	

Table 16: Schedule of the 1st Training

	Date 2016	Training Contents	Training Venues
1	7 February (Sun)	Colombo→Narita International Airport	
2	8 February (Mon)	JICA Briefing and orientation Training Orientation	JICA Tuskuba Int. Center RIC-Tsukuba
3	9 February (Tue)	Instrument calibration work Calibration of humidity, rainfall and wind measurement instrument	RIC-Tsukuba
4	10 February (Wed)	Calibration of thermometers and barometers Site visit to the radiosonde observation	RIC-Tsukuba
5	11 February (Thu)	Holiday	
6	12 February (Fri)	Visit to the surface observation site Lecture on meteorological observations Visit to the forecast and observation operation rooms	Head Quarters, JMA Tokyo Regional Headquarter, JMA
7	13 February (Sat)	Cultural visit to Tokyo	RIC-Tsukuba
8	14 February (Sun)	Cultural visit to Kamakura	RIC-Tsukuba
9	15 February (Mon)	Calibration of thermometer at the freezing point Testing of phygrometers using the Assmann phygrometer	RIC-Tsukuba
10	16 February (Tue)	Calibration of thermometer at the thermal bath	RIC-Tsukuba
11	17 February	Calibration of barometers	RIC-Tsukuba

	(Wed)		
12	18 February (Thu)	Practice on calibrations of barometers and thermometers	RIC-Tsukuba
13	19 February (Fri)	Production of calibration manual of barometers and thermometers Evaluating the training and awarding certificates	RIC-Tsukuba JICA Tsukuba Int. Center
14	20 February (Sat)	Narita International Airport→Colombo	

- The 2nd training Program

  This program was designed for the DOM staff to learn the latest knowledge on meteorological observations for planning the modernization of DOM weather services. The number of the trainees was increased from the originally planned 4 people to 8 people so that staff at various levels such as from a deputy director to heads of the regional offices of DOM could discuss the modernization. The training program was implemented by the staff of JMA and a meteorological instrument manufacturer, and a professor of Kyoto University specialized in meteorological observations during two weeks in February 2017. At the end of the training, all the trainees discussed problems and issues in promoting the modernization of the meteorological observations in the future DOM, and compiled a proposal as the final report, and submitted it to the Director General of DOM after their return to Sri Lanka.

  The contents of the 1st training are summarized in Table 17.

Table 17: Summary of the 2nd C/P Training Program

Meteorological Observations		
Outline of the training	Training Period	February 13, 2017 to February 24, 2016 (12 days)
	Training Venues	JICA Tokyo International Center Head Quarters, JMA Tokyo Regional Headquarter, JMA Aerological Observatory, JMA Meteorological Instrument Center, JMA (RIC-Tsukuba) Kumagaya Local Meteorological Observatory Meisei Isesaki Factory
	Participants	■ Mr. A. G. M. M. Wimalasooriya (Deputy Director in charge of meteorological instruments) ■ Mr. P. A. A. Priyantha (Meteorologist, Computer Division)

		■ Ms. K. G. P. S. Wijerathne (Meteorological Officer, Radar Division) ■ Ms. G. R. L. Palihapitiya (Meteorological Officer, National Meteorological Centre) ■ Mr. D. M. Podibanda (Meteorological Officer, Kurunegala Regional Office) ■ Ms. M. B. Iranganie (Meteorological Officer, Puttalam Regional Office) ■ Ms. T. D. Malani (Communication Officer, Communication Divison) ■ Mr. W. A. T. K. Palitha de Silva (Telecommunication & Radar Technical Officer, Electronic Divison)
Training purposes	Acquiring knowledges on the latest technology of meteorological observations in order to make plan of the modernization of meteorological observation of the DOM	

Table 18: Schedule of the 2nd Training

	Date 2017	Training Contents	Training Venues
1	12 February (Sun)	Colombo→Narita International Airport	
2	13 February (Mon)	JICA Briefing and orientation Training Orientation	JICA Tokyo Int. Center
3	14 February (Tue)	Meteorology for surface observation Manual surface observation	
4	15 February (Wed)	Automated surface observation	
5	16 February (Thu)	Operation of automated surface observation Data quality check	
6	17 February (Fri)	Visit to the surface observation site Lecture on remote-sensing observations Visit to the observation operation rooms	Head Quarters, JMA Tokyo Regional Headquarter, JMA
7	18 February (Sat)	Cultural visit to Kamakura	
8	19 February (Sun)	Tokyo→Kumagaya	
9	20 February (Mon)	Services of regional meteorological observatories of JMA	Kumagaya Local Meteorological Observatory, JMA

		Manufacturing of meteorological instruments	Meisei Isesaki Factory
10	21 February (Tue)	Lecture on the JMA meteorological satellite Site visit of the Doppler Radar for Aviation Weather Haneda→Tsukuba	Head Quarters, JMA Haneda International Airport
11	22 February (Wed)	Upper-air observation Meteorological instrument calibration Tsukuba→Tokyo	Aerological Observatory RIC-Tsukuba
12	23 February (Thu)	Analysis on the curent situations of the meteorological observation in Sri Lanka Discussion on the modernization of the meteorological observation in Sri Lanka	JICA Tokyo Int. Center
13	24 February (Fri)	Planning of the modernization of the meteorological observation in Sri Lanka Evaluating the training and awarding certificates	JICA Tokyo Int. Center
14	25 February (Sat)	Narita International Airport→Colombo	

The photos of the trainers and trainees in the 1st and 2nd C/P training Programs are shown in Photo 2-1.

Photo 2-1 The trainees, trainers and training conductors of the JICA C/P training program 'Meteorological Instrument Calibration (left)' and 'Meteorological Observations (right)'.

2-6 Revision of the Project Design Matrix (PDM)

■1st Revision (October 14, 2014)

The revision of certain items to make the descriptions more concrete were proposed and approved at the Joint Coordinating Committee (JCC) conducted on October 14, 2014 at the Ministry of Disaster Management.

The original PDM and 1st revised PDM (revised parts: blue color) are attached hereunder.

PROJECT DESIGN MATRIX (PDM) [Original]

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1 Traceability of meteorology instruments (Availability of national standards/frequency of inspection) 2 Number of missing observation data 3 Accuracy of rainfall forecast in the selected stations. 4 Number of selected station where weekly forecast is enabled in trial basis.	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes.
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved. 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened. 3. Capacity of weather forecasting is improved using obtained meteorological data. 4. Warning criteria is elaborated.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project. 1.2 Training on inspection and repairing of AWS is conducted for XX% of the relevant DOM staff. 2.1 Data from AWS are obtained and	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	Necessary budgets for maintaining meteorological equipment are allocated to DOM in 2015 and 2016.

5. The method of dissemination and contents of meteorological information are improved.	made available to a full extent in DOM. 2.2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least XX persons in DOM obtain ability to use the weather guidance. 3.2 At least XX persons in DOM obtain ability to forecast short range sea surface wind. 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM Website is increased by XX% or more.	- The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the short range forecast - Training records on the weekly range forecast - Draft warning criteria - Educational material for weather services	
Activities	**Inputs**		**Pre-conditions**

1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments. 1.4 Conduct training on calibration of conventional and AWS equipment. 1.5 Review and revise the Standard Operation Procedure for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule. 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. 2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters. 2.3 Review the current situation on GTS/MSS, and identify the issues to be improved. 2.4 Replace and upgrade the GTS/MSS 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct training on development of weather guidance products for short range (36 hrs.) and weekly weather forecast including their forecast verification techniques.	Japanese side <u>Long-term expert:</u> Chief Adviser / Expert of Weather Services <u>Short-term experts:</u> - Expert of Meteorological Observation - Expert of Satellite Data Analysis - Expert of Meteorological Observation Technology - Expert of Weather Forecasting / Weather Guidance Method - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant <u>Machinery and Equipment:</u> - Desktop or Laptop Computers - Desktop Computer for WIS - Display for Briefing of Weather Forecasting - Laptop Computer with data reader to download data from AWS logger	Sri Lanka side <u>Administration:</u> Project Director, Project Manager <u>Counterpart personnel:</u> C/P personnel from the relevant divisions under DOM <u>Facilities and Equipment:</u> - Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment <u>Budgetary Arrangement by DOM:</u> Administration and local operation costs	The appropriate counterpart personnel to participate in a series of training provided by the Project are secured.

3.3 Prepare weather guidance products for short range and weekly at the selected stations. 3.4 Conduct training for short range sea surface wind forecast utilizing satellite data. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). 3.6 Review and evaluate the seasonal weather forecasting methods. 3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data. 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and occurrence of lightning. 5.1 Review the contents of current meteorological information, and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of website of the headquarters. 5.5 Prepare smartphone compatible website. 5.6 Prepare educational material (ex. website, CDs, leaflet and publications) for weather services.	- Multifunction machine (Printer / Photocopy) - GTS/Message Switching System - Travelling Calibration System (temperature and pressure sensors) - Second Standard Instruments (electric temperature and pressure sensors) - Spare parts for AWSs including		

PROJECT DESIGN MATRIX (PDM) [Revised-1]

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM. 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM.	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1 Traceability of meteorology instruments (Availability of national standards/frequency of inspection) 2 Number of missing observation data 3 Accuracy of rainfall forecast in the selected stations. 4 Number of selected station where weekly forecast is enabled in trial basis.	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes.
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved. 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project. 1.2 Training on inspection and repairing	- Annual administration reports of DOM - Record of the JCC meetings - Progress reports of the Project - Work reports of the short-term	Necessary budgets for maintaining meteorological equipment are allocated to DOM in

3. Capacity of weather forecasting is improved using obtained meteorological data. 4. Warning criteria is elaborated. 5. The method of dissemination and contents of meteorological information are improved.	of AWS is conducted for 70% of the relevant DOM staff. 2.1 Data from AWS are obtained and made available to a full extent in DOM. 2.2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance. 3.2 At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind. 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM Website is increased by 30% or more.	experts - Work reports of the consultant team - Website of DOM - The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the weather guidance (up to 36 hours ahead and 168 hours ahead) - Draft warning criteria - Educational material for weather services	2015 and 2016.
Activities	**Inputs**		**Pre-conditions**
1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments.	**(Japanese side)** Long-term expert: Chief Adviser / Expert of Weather Services Short-term experts: - Expert of Meteorological Observation	**(Sri Lanka side)** Administration: Project Director, Project Manager Counterpart personnel: C/P personnel from the relevant divisions under DOM	The appropriate counterpart personnel to participate in a series of training provided by the Project are secured.

1.4 Conduct training on calibration of conventional and AWS equipment. 1.5 Review and revise the Standard Operation Procedure for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule. 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. 2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters. 2.3 Review the current situation on GTS/MSS, and identify the issues to be improved. 2.4 Replace and upgrade the GTS/MSS 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification. 3.3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations. 3.4 Produce weather forecast guidance of sea wind at the selected stations. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID).	- Expert of Satellite Data Analysis <u>Experts dispatched from the consultant:</u> - Leader / Expert of Weather Forecasting - Expert Weather Guidance - Expert of Meteorological Observation Technology - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant <u>Machinery and Equipment:</u> - Laptop PC for the training of weather guidance method - Laptop PC for downloading data from AWS logger - Display for Weather Briefing - Multifunction machine (Printer / Photocopy) - Printer - Portable Calibration System (Portable AWS)(temperature, atmospheric pressure, humidity, wind direction and wind speed) - Standard Meteorological Instrument (electric temperature and pressure	<u>Facilities and Equipment</u> - Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment <u>Budgetary Arrangement by DOM</u> Administration and local operation costs	

3.6 Verify and improve the existing methods of seasonal forecast. 3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data. 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning strike. 5.1 Review the contents of current meteorological information and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of website. 5.5 Prepare smartphone compatible website. 5.6 Prepare educational materials (disaster awareness materials) for the weather services.	sensor) - Spare parts for AWS - Laminating machine - Laptop PC for the training of editing a website - Software for editing a website - Additional lightning protection system - Public Address System for Open Class - Projector for Open Class - Spare bulb for Projector - Extension power cable for Open Class- - GTS/Message Switching System (including installation, adjustment, and initial operation instruction)		

3. Actual Activities done under the Project and Outputs

Fundamental Policy on the Project Activities

In order to effectively implement the project, all the activities were conducted in accordance with the following policies.

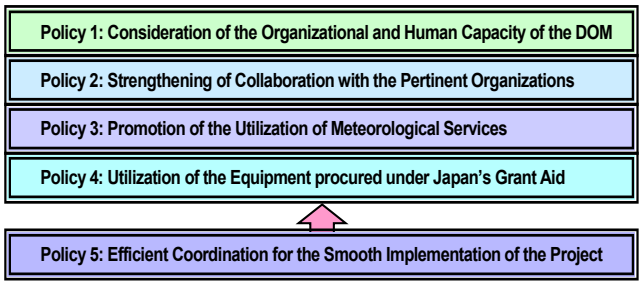


Figure 6: Flowchart of Fundamental Policy

[Policy 1: Consideration of the Organizational and Human Capacity of the DOM]

- To give due consideration to the organizational size of the DOM

A lot of tasks have to be performed with a limited number of staff members available in each of the DOM divisions. Accordingly, the Consultant Team made the activity schedule of the Project considering the task details, working hours (shift working) and monsoon seasons when the meteorological services get busy. The development of human resources is a key element in establishing the framework to continuously carry out the tasks with a limited number of the DOM staff. The Consultant Team also intended to promote the transfer of basic technical skills to the staff and engineers of agencies aside from the DOM.

- To transfer practical skills

The transfer of the skills in the Project was in accordance with the weather phenomena and characteristics of the disasters in Ski Lanka, capacity of the DOM, technical level, current observation/forecasting system, disaster prevention system, current situation of the outside users and so on. The practical and basic skills to enable the DOM staff to perform the tasks in the course of or after the Project will mainly be transferred so that the effect of the Project will be continuously brought about even after the termination of the Project. Specifically, the establishment of reasonable observation and quality control systems based on the current meteorological observation policy and methodology and creating the meteorological forecasting and warning using the forecasting technology which can be relatively easily understood and done by the DOM staff with their current level of technical capability while making maximum

use of the existing data, will be performed..

[Policy 2: Strengthening of Collaboration with the Related Organizations]

In order to mitigate the damages caused by natural disasters in Sri Lanka, it is important that the DOM accurately grasps weather conditions through the conduct of meteorological observations and that disaster management agencies provide their services through comprehensive inter-agency collaboration. As it is clear from the organization chart shown below, government agencies responsible for disaster prevention can easily communicate with each other as they are structurally assembled under the Ministry of Disaster Management (MDM) including the DOM. Since the DOM takes the role of providing highly accurate forecasts and warnings and transmitting them to other agencies and organizations in a prompt manner, the information received from the DOM acts as a trigger for the initial responses to be taken by the disaster-related agencies. In the Project, technical transfer of the necessary technical skills to the DOM will be performed so that the collaboration between the DOM and other disaster-related agencies will be strengthened and that the DOM will be able to promote the Sri Lankan people's understanding of the meteorological information provided.

[Policy 3: Promotion of the Utilization of Meteorological Services]

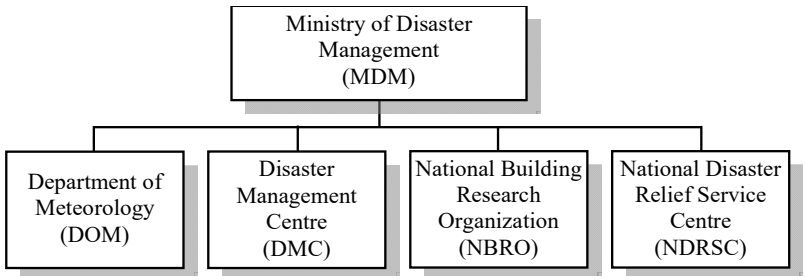


Figure 7: Organization Structure of Ministry of Disaster

Source: Ministry of Disaster Management, Sri Lanka (HP)

The DOM takes on the responsibility of providing accurate and timely meteorological information that meets the users' needs and the policy of this Project is to transfer the technology necessary to achieve the aforementioned task. It is believed that once the users obtain a sufficient level of meteorological knowledge, it will enable them to effectively and efficiently use the meteorological information in a practical sense.

In Sri Lanka, although the importance of meteorological information is deeply recognized, it is a reality that the utilization of this meteorological information in a timely and efficient manner

is difficult. In the Project, brochures (e.g., Beaufort scale with illustrations) and animated cartoons to promote the understanding of meteorological information by students and educators specifically were created for the activities, such as open classes, concerning the dissemination of meteorological information to be held mainly in the area often stricken by torrential rains and at elementary and junior high schools in Colombo.

[Policy 4: Effective Utilization of the Equipment Procured under Japan's Grant Aid]

Utilization of all the equipment procured under the Japan's Grant Aid in the Project was one of the policies for the Project Activities. All the equipment is being handled, maintained and managed by the staff of the department. In addition, the tasks which require electronic technology, such as the operation and maintenance of the upper-air observation equipment and the aviation weather information receiving system are being carried out at the Electronic Maintenance Division. Accordingly, the staff at those divisions has common and technical knowledge of the operation and maintenance of the data communication equipment. The DOM dispatches its engineers to 38 observation stations twice a year to perform cleaning, inspection and preventive maintenance of the Automatic Weather Observation System (AWS) procured under Japan's Grant Aid. The engineers inspect the sensors, data logger and photovoltaic power source of the AWS and check the earth resistance. In order to stably operate the procured equipment on a long-term basis, the routine tasks in place, such as the inspections and troubleshooting steps were set up.

[Policy 5: Efficient Coordination for the Smooth Implementation of the Project]

The DOM needs to incorporate the maintenance and operation cost of the Project into its annual budgetary request which is submitted to the Ministry of Finance and Planning (MOFP) of Sri Lanka in addition to the budget allocation needed for the smooth implementation of the Project and the tax exemption application procedure for the procured equipment. It is necessary to prepare the budgetary request for each year of the Project period by the end of August of every year. Along with the DOM, the estimation of the required annual budget after the commencement of the Project was prepared and provided. The Sri Lankan fiscal year starts on January 1 and ends on December 31. The procedures for applying for the budget for the following year are as follows.

- At the end of August: Submission of the budgetary request to the Ministry of Finance and Planning (MOFP)

↓

- MOFP: budgetary discussion/content confirmation
  ↓
- MOFP: Submission of all the budgetary requests to the Parliament
  ↓
- December: Approval of the annual budget for the following year by the Government of Sri Lanka

In addition, in order for the equipment of the Project to be procured and installed in a prompt and efficient manner, the Consultant team proactively provided the required assistance to the DOM.

Output 1: Capacity on maintenance and calibration of meteorological observation equipment is improved.

Activities described in the PDM are as below.

1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved.
1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration.
1.3 Establish the traceability of meteorological instruments.
1.4 Conduct training on calibration of conventional and AWS equipment.
1.5 Review and revise the Standard Operation Procedure for manual and AWS observations.
1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS.
1.7 Conduct training on inspection and repairing of AWS.
1.8 Review the upper air observation schedule.

Actual activities for Output 1 are described below.

<Review the current situation on the maintenance and calibration of meteorological equipment and identify the issues to be improved>

- Through several discussions with the DOM and the Baseline Study conducted, the current issues indicated below to be improved upon were identified.
  - The instruments used for calibration of weather observation instruments were getting outdated.
  - The DOM did not have the equipment to be used for the calibration of weather observation instruments.
  - The standard instruments used for the calibration of meteorological observation instruments were not calibrated with international standard instruments for a long time.
  - There are no guidelines and manuals for the calibration of meteorological instruments.

- The manuals for maintenance were not revised for a long time since the original document of the manuals for meteorological instruments were prepared in PDF format only and the revision based on the current situation cannot be done smoothly.
- Baseline Survey Report was prepared and submitted to JICA and the DOM.

<Procurement of the necessary instruments for the calibration of meteorological equipment>

- All the required documents necessary for the procurement process including the technical specifications for the new instruments for the calibration of meteorological equipment were prepared.
- Procurement of all the planned equipment and standard instruments necessary for the calibration has been completed.
- Observation accuracy of the procured instruments was to be secured as follows.
  - Electric Thermometer: Calibration Certificate of the Laboratory certified by ISO/IEC17025
  - Electric Barometer: JMA Certificate
  - Portable Automatic Weather Station: JMA Certificate

<Establishment of a team responsible for proper maintenance and calibration>

The team responsible for proper maintenance and calibration was established by the staff of the "Conventional Instrument and Observation Management Division" and "Electric Engineering Division."

<Establish the traceability of meteorological instruments>

(Activity of the Long Term Expert)

<Conduct training on calibration of conventional and AWS equipment>

(Activity of the Short Term Expert)

The action process of this activity is shown in Figure 8. The consultant experts made the procurement of the standard instruments and the instrument calibration devices for two periods

and conducted trainings for handling of the instruments. As the results, the preparation of the equipment was completed in July 2016. At the same time, in February 2016, the JICA C/P program for meteorological instrument calibration was conducted at RIC-Tsukuba of JMA, and four DOM staff members from the DOM instrument division and the DOM electronics division acquired the latest instrument calibration techniques.

After July 2016 when the procurement of the instrument calibration equipment was finished, the DOM instrument maintenance and calibration team learned the operation of the new equipment. Meanwhile, until then, the instrument calibration had been done in one of the corners of the office of the DOM instrument division and it was inefficient in terms of space. Through the discussion with C/P, a new instrument calibration laboratory room was designed, and an instrument calibration laboratory was constructed in January 2017 with the expenses borne by both JICA and DOM and with the participation of personnel of DOM (Photo 3-1).

In January 2017, two short-term experts visited from RIC-Tsukuba of JMA and conducted the training for 6 days in the new instrument calibration laboratory (Photo 3-1). 5 staff from the DOM instrument division, 4 staff from DOM's related divisions, 5 from the DOM regional offices learned the theory, techniques and operation of instrument calibration. The reason why the staff from the DOM regional offices were participated in the training course is to ensure the sustainability of the project by taking into account the future personnel transfers in the DOM.

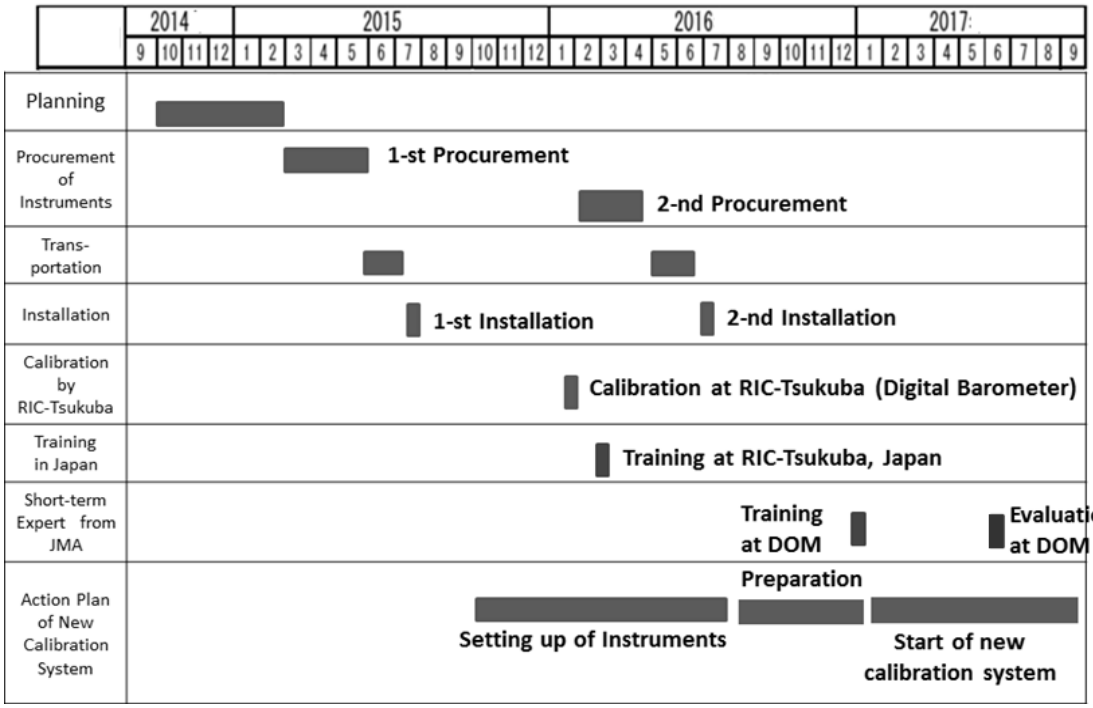


Figure 8: Processes up to the Establishment of the Traceability of Meteorological Instruments

Subsequently, the maintenance and calibration team conducted instrument calibration and sent the result of the calibration to the short-term experts of RIC-Tsukuba. Comments from the experts have contributed to improving the calibration scheme by the DOM staff.

In June 2017, the same two short-term experts from RIC-Tsukuba again gave instrument calibration training for 5 days to 21 DOM staff (7 staff of the instrument division, 4 from related divisions of DOM, 11 from the regional offices).

Photo 3-1 The instrument calibration laboratory, its opening ceremony and the short-term expert training on the meteorological instrument calibration at the laboratory

Through the series of training, the traceability of the instrument has been established with respect to pressure and temperature which was the initial target of the project. The new instrument calibration service was started in the DOM instrument division concerning pressure and temperature. The route of the traceability of barometers is illustrated in Figure 9.

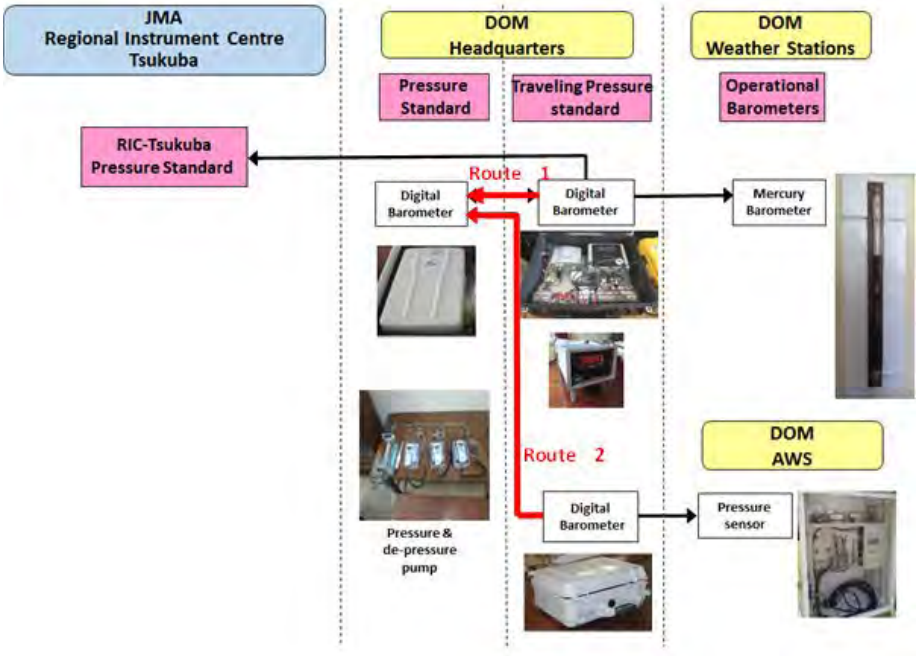


Figure 9: Route of the Traceability of Barometers in DOM

On the other hand, concerning humidity and wind speed, standard instruments and calibration devices were not installed in this project. In the series of the trainings in the project, comparison methods between operational instruments at the DOM regional offices and the DOM sub-standard instruments (portable AWS) procured in the project were introduced. The full traceability for humidity and wind speed instruments, however, has not been established.

<Preparation of "Calibration and Maintenance Manual for Meteorological Instruments" and "Inspection Guideline for Meteorological Instruments">

Generally, it is essential to prepare documents such as guidelines and manuals for surface weather observation and instrument calibration in national meteorological organization, but the DOM has not had systematically compiled documents on them. For this reason, based on the cooperation of long-term experts and consultant teams, training materials prepared by short-term experts, etc. are also incorporated and draft of the "Manuals for Meteorological Instrument Calibration", "Manuals for Meteorological Instrument Maintenance" and "Guideline to Meteorological Instrument Calibration" were prepared. By these, we aimed at standardization of ground weather observation and inspection method, and improved quality concerning general ground weather observation including traceability of instruments. The contents of the prepared "Manuals for Meteorological Instrument Calibration" and "Manuals for Meteorological Instrument Maintenance" are as follows.

- Prepared "Manuals for Meteorological Instrument Maintenance"
    1) Laboratory/traveling Calibration Manual for Mercury Barometers
    2) Laboratory Calibration Manual for Electric Barometers
    3) Laboratory Calibration Manual for Glass Thermometers
    4) Laboratory Calibration Manual for AWS Electric Thermometers
    5) Traveling Calibration Manual for AWS Electric Barometers
    6) Traveling Calibration Manual for Glass Thermometers and AWS Electric Thermometers using a Thermos Flask
    7) Setting Manual for Index Correction of AWS Electric Barometers
    8) Calibration Sheet

- Prepared "Manuals for the Maintenance of Meteorological Instruments"
    1) Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System
    2) Preventive Maintenance Record for Automatic Weather Observation System
    3) Basic Trouble Shooting and Inspection Procedure for Automatic Weather Observation System
    4) Spare Parts (Sensor) Replacement Procedure for Recovery of Automatic Weather Observation System
    5) Explanatory note for Meteorological Instruments

Trainings on the calibration of AWS and Synop observation Station were conducted on "Portable Automatic Weather Station Operation Manual"

Based on the results and lessons learned about the training on calibration and maintenance of AWS and Synop observation stations, draft of the "Manuals for Meteorological Instrument Calibration", "Manuals for Meteorological Instrument Maintenance" and "Guideline to Meteorological Instrument Calibration" were revised.

<Monitoring the state of the calibration and maintenance in accordance with the manuals and guidelines created>

- After training "Meteorological Instrument Calibration 2" by the short-term experts in January 2017, 110 glass temperature thermometers, two mercury barometers, and two electric barometers were calibrated by the DOM staff. At the same time, comparative tests of the operational barometers/thermometers with the portable AWS barometer/thermometer were conducted by DOM staff at 5 DOM Regional Offices. These test results were sent to RIC-Tsukuba, and the short-term experts who had visited Sri Lanka in January 2017 provided DOM with comments on the results. As a result, it was confirmed that the DOM staff in this project had acquired the instrument calibration technique on pressure and temperature.
- Comparative observation based on the prepared "Portable Automatic Weather Station Operation Manual" has already been conducted at 8 existing observation stations and the

remaining 14 observation stations are scheduled to be conducted within 2017, as confirmed.

- Cleaning inspections based on the prepared "Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System" have been conducted at all observation stations and the implementation rate was 95%

<Review and revise the Standard Operation Procedure for manual and AWS observations>

The contents of the existing standard operating procedure of meteorological instruments and automatic weather observation system have been reviewed and revised as necessary after analyzing the problems.

<Review and revise the user's guide for the inspection and repair (sensor parts replacement) of the automatic weather observation system>

- All manuals to be revised in the project were newly prepared in Microsoft Word Format (doc. format) which can be easily updated since the format of the electronic data of all the existing manuals was "pdf".

- As a result of the discussions with the DOM, the user's guide for the inspection and repair (sensor parts replacement) of the AWS were reviewed and revised mainly by improving the following items.
  - Visualization by inserting photos and figures;
  - Correction by model change of wind direction/speed sensor;
  - Descriptions of inspection items (grounding resistance measurement etc.) added after the handover of the Automatic Weather Observation System (AWOS) procured under Japan's grant aid; and,
  - Selection and editing of the most important parts from the existing manufacturer's manuals.

In accordance with the following procedures, the review and revision of the "Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System" and "Preventive Maintenance Record for Automatic Weather Observation System" were implemented.

1) Implementation of inspection on trial basis with the DOM using existing manual
2) Identification of the points to be revised from the existing manuals
3) Implementation of the experimental re-inspection using the revised manual
4) Implementation of re-verification of the revised content and proofreading

In accordance with the following procedures, the review and revision of the "Basic Troubleshooting and Inspection Procedure for Automatic Weather Observation System" and "Spare Parts (Sensor) Replacement Procedure for Recovery" were implemented.

1) Preparation of simulated fault condition using real equipment.
2) Validation of inspection procedure using existing operation and maintenance manual
3) Identification of the points to be revised from the existing operation and maintenance manuals
4) Implementation of re-verification of the revised content and proofreading

Since the existing operation and maintenance manuals (prepared by the equipment manufacturer) of the automatic weather observation system had considerable thickness and is composed of several volumes, it was difficult to figure out the required section/s needed and peruse it carefully. Therefore, it was not used frequently in daily maintenance. Only the important page is selected as an outline, a photograph or a diagram is newly inserted so that it is easy to understand, and "Basic Troubleshooting and Inspection Procedure for Automatic Weather Observation System" and "Spare Parts (Sensor) Replacement Procedure for Recovery" were reedited.

<Construction of additional lightning protection poles>

Since three observation stations, Ratnapura, Polonnaruwa and Aralagatonwila, had frequent problems due to lightning strikes in the Automated Weather Observation System and communication system that was established through the Grant Aid from Japan, the installation of the following additional lightning protection facilities were implemented in collaboration with DOM Electric Engineering Division Staff through practical training in this project.

- ✧ Lightning Rod: 15m height
- ✧ Connection between lightning rod and earth rod: Copper flat bar
- ✧ Earth resistance value: 5Ω or less
- ✧ Grounding Type: “Common Earth” with additional earth rod and existing earth rod interconnected

Additional earth rod and existing earth rod interconnected

"Common Earth (Equipotential Bonding)" has the advantages described below

<In case "Common Earth" is not adopted>
When lightning strikes the lightning rod, if each earth is disowned in the figure on the right, a potential difference occurs between the earths. Due to this potential difference, an electric current flows to the equipment connected to another earth, and the equipment is damaged.

<In case "Common Earth" is adopted>
When the earth electrodes are connected to each other, lightning strikes the lightning rod, a potential difference does not occur between the respective earths. Therefore, the lightning current does not flow to other equipment, and damage to the equipment can be prevented.

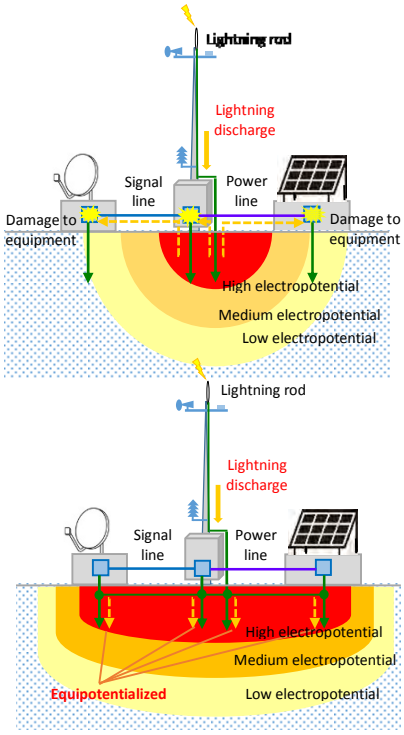


Figure 10: Advantages of Common Earth

Table 19: Number of Failures of the Equipment due to Lightning

	Before installation of Additional Lightning Protection (November 2009 – February 2015)	After installation of Additional Lightning Protection (February 2015 – June 2017)
Frequency of damage caused by lightning at Ratnapura、Polonnaruwa and Aralagatonwila	9 times	None

<Review the upper air observation schedule>

(Activity of the Long Term Expert)

DOM is implementing upper-air observations on pressure, temperature, humidity, wind speed and wind direction by using the GPS radiosonde iMS-100 manufactured by Meisei Electric Company of Japan and a data processing PC, which was introduced by the WMO Voluntary Cooperation Program in 2009. The observation is operated at the DOM head office in Colombo (Figure 11) at 11:30 AM local time (06:00 UTC) at three times per week (Monday, Wednesday and Friday). Two DOM observers and one helper are engaged in the radiosonde observation (Figure 11).

Pilot balloon observations are being made for measuring lower to middle levels winds by the way that observers manually track a rising-up smaller balloon using a theodolite. Four DOM observation sites at Mannar, Trincomalee, Hambantota and the DOM Head office in Colombo are implementing pilot balloon observations (Figure 11). The observations are made three times per day at 05:30, 11:30 and 17:30 in local time (00, 06, 12 UTC). The pilot balloon observations in Colombo at 11:30 on Mondays, Wednesdays and Fridays are currently not being implemented, so as not to overlap with radiosonde observations. Two observers and one helper at each observation station are engaged in the pilot-balloon observation.

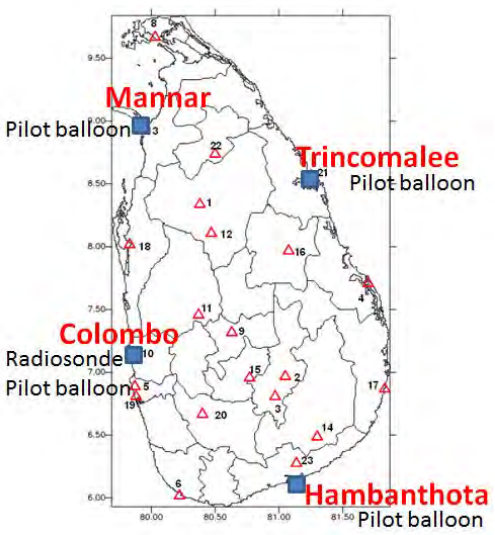


Figure 11: Upper-Air Observation Sites

The observation data of the radiosonde and pilot balloons are sent to the GTS of WOM immediately after the observations in order to exchange the data among national meteorological organizations in the world.

The long-term expert surveyed the current situation of the radiosonde observation in Colombo, and also visited Mannar in September and Trincomalee in March 2017 to survey the pilot balloon observations. On the basis of these surveys, he submitted DOM the report recommending the implementation of daily radiosonde observation.

The daily radiosonde observation, however, has not been started yet due to shortage of fund and personnel in DOM. It was also found that the safety at the time of filling up hydrogen into a balloon in DOM was not sufficient.

Photo 3-2 launching of a radiosonde, data processing and Pilot balloon launching/observation.

A short-term expert of JMA was invited to DOM for more detailed survey on the situation of the current upper-air observation in DOM in June 2017 (Photo 3-3). The training on the latest upper-air observation systems was also conducted. 22 staff members of DOM (2 of the DOM Radar Division, 14 from the relevant DOM divisions and 6 from the DOM regional offices) were participated in the training and the results of the discussions on improvement of the current upper-air observation of DOM were summarized as the report, which was submitted to the Direct General of DOM.

Photo 3-3 The short-term expert training "Upper-air Observation".

The outlines of the report are as follows,

- The schedule of the radiosonde observations of DOM: three times per week, should be shifted to daily observation. Until the daily observation throughout a year is established, daily operation should be made during two inter-monsoon seasons, when the risk of heavy rainfall is higher than in the Monsoon seasons,
- It is reasonable that the existing pilot-balloon observations are continued in order to monitor the mesoscale circulation over Sri Lanka. Installation of a wind profile network system should be discussed in a mid-term or long-term action plan of DOM,
- The hydrogen gas generator at the DOM Head Office was installed in 1974, and has sometimes made trouble. It should be replaced to a new one as soon as possible.

- A color printer is required to make prints of figures of observation results. A color printer will be supplied from JICA by the end of July 2017,
- The figures of Emagram, Tephygram and relating observation results should be automatically saved in the Meisei analysis computer. The short-term expert will ask Meisei Co. the way to save the figures automatically in the analysis program,
- A buoyancy weight is required to fill hydrogen gas into balloons more easily and more safely. A 1000-gr buoyancy weight was provided from the short-term expert.
- More detailed training on radiosonde-observation should be given to more senior officers in DOM.

More detailed guide-line and manuals on the upper-air observation should be prepared. The observation manual for iMS-100 was prepared in JMA and was provided to DOM from JMA.

<Trainings for "Output 1">

(1) Trainings conducted by the Consultant Team

Records of trainings on the Output 1 are summarized in the following table.

Table 20: Training: Maintenance and Calibration of Meteorological Observation Equipment

Date	Time	Venue	Attendee(s)	Conductor	Contents
January 23, 2015	9:00-10:30 14:30-16:30	Electronics Engineer's Office	4	T. Endo	■ Installation Method of Lightning Protection System
January 28, 2015	12:00-20:00	Polonnaruwa Station	4	T. Endo	■ Installation Work of Lightning Protection System
January 29, 2015	07:00-17:00	Aralaganwila Station	4	T. Endo	■ Installation Work of Lightning Protection System
July 09, 2015	10:00-12:00	Instrument Division	2	T. Endo	■ Operation & Maintenance of Standard Instruments
July 10, 2015	11:00-12:30, 14:00-15:30	Instrument Division	3	T. Endo	■ Operation & Maintenance of Standard Instruments & Portable AWS
December 4, 2015	10:30-11:30	Instrument Division	5	T. Endo	■ Calibration Method and Training Schedule
December 8, 2015	10:30-13:30	Instrument Division	4	T. Endo	■ Installation and Observation of Portable AWS
December 10, 2015	14:30-16:00	Instrument Division	4	T. Endo	■ Installation and Observation of Portable AWS
December 14, 2015	14:30-16:00	Instrument Division	6	T. Endo	■ Data Download from

					Portable AWS
December 16, 2015	9:00-16:00	Instrument Division	6	T. Endo	■ Field Observation by Portable AWS
December 17, 2015	10:00-12:00 13:30-15:00	Instrument Division	6	T. Endo	■ Comparisons of Observation Data
April 28, 2016	10:00-11:00	Instrument Division	4	T. Endo	■ Discussion about the outline of weather observation guideline
May 2, 2016	10:00-11:30	Electronics Engineer's Office	2	T. Endo	■ Practice & Review of Cleaning/Maintenance Procedure
May 2, 2016	13:30-14:30	Instrument Division	3	T. Endo	■ Discussion about the outline of weather observation guideline
May 3, 2016	13:30-14:30	Instrument Division	3	T. Endo	■ Discussion about contents of weather observation guideline
May 6, 2016	10:00-16:00	Instrument Division & Observation Division	12	T. Endo	■ Additional Training on the calibration method
May 7, 2016	9:00-12:30	Instrument Division & Observation Division	10	T. Endo	■ Additional Training on the calibration method
July 12, 2016	15:00-16:00	Electronics Engineer's Office	2	T. Endo	■ Discussion about Cleaning/Maintenance Manual
July 13, 2016	14:30-15:30	Instrument Division & Observation Division	3	T. Endo	■ Implementation of Observation Data Comparison
March 31, 2017	11:00-12:30	Conference Room, Observation Field	23	Y. Uchida T. Endo	■ Cleaning/Maintenance for Automatic Weather Station

(2) Trainings conducted by the short-term experts and the JICA C/P training Programs

"Meteorological instrument calibration 1" and "Meteorological instrument calibration 2" were implemented by short-term experts. "Meteorological instrument calibration" and "Meteorological observations" were conducted as the JICA C/P training Programs.

<Remarks on "Output 1"＞

As a summary of the Output 1, the following table shows the items the DOM is able to implement under the Project and the items the DOM should solve/improve after completion of the Project.

Table 21: Remarks on "Output 1"

Output 1: Capacity on maintenance and calibration of meteorological observation equipment is improved.
Items the DOM is able to implement under the Project
■ To establish the traceability of observation instrument through the implementation of higher accurate calibration using new standard instrument, calibration equipment, prepared guidelines and manuals, and newly prepared instrument inspection room ■ To steadily implement the tasks regarding the automatic weather observation system and the manual observation, and smoothly conduct the training on these tasks, by using the revised guidelines/manuals for easy and comprehensive understanding. These guidelines/manuals were bound, and distributed to relevant departments of the DOM including the local weather observation stations. ■ To update the revised guidelines/manual any time as necessary, since the data of revised guidelines/manuals is stored in an updatable format (Microsoft, word format) ■ To take effective countermeasures against lightning in observation stations which are vulnerable to lightning strikes, since it was demonstrated how to reduce the damage caused by lightning strike by adding the common earth type lightning rod.
Items the DOM should solve/improve after completion of the Project
■ To ensure observation accuracy continuously through the periodic calibration of the maintained meteorological observation instruments at an internationally accredited test center such as RIC - Tsukuba. ■ To establish traceability for the AWS hygrometer and rain gauge, since the standard instrument and calibration equipment are not installed now. ■ To periodically conduct training for staff in charge of maintenance of the automatic weather observation system and manual observation, and confirm procedures and points in order to reduce mistakes. ■ To occasionally reflect the lessons learned by each staff in daily work to the revised guidelines/manuals in order to maintain and manage the automated weather observation system more smoothly and accurately. ■ To conduct daily upper air observation by securing budget and personnel from the viewpoint of improving accuracy of weather forecast and international cooperation

- Output 2: Transmitting and receiving capacity of various kinds of meteorological data is strengthened.

Activities described in the PDM are as below.

2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved.
2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.
2.3 Review the current situation on GTS/MSS, and identify the issues to be improved.
2.4 Replace and upgrade the GTS/MSS.

Actual activities for Output 2 are described below.

<Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved>

- Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified.
  - Operation of the existing VSAT satellite data communication system is unstable, and it is frequently discontinued.
  - VSAT satellite data communication system manufactured by Gilat Satellite Networks Ltd. of Israel.
  - Since the communication satellite (INSAT3E) currently in use has already passed its service life of 10 years, it needs to be replaced within the next few years as its communication performance has deteriorated.
  - For migration of the communication satellite with a new one, technical supports from the Gilat agent in India is indispensable and the cost (communication satellite replacement assisting cost) was estimated to be about 10.3 million yen (100,000 USD including one-year support)
- Baseline Survey Report was prepared and submitted to the JICA and the DOM.

<Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters>

The following items concerning the backup of the existing VSAT system for transmitting the observation data between the Automatic Weather Observation System and the DOM Head Office were examined. As a result, it was decided to adopt IP-VPN as the backup of the existing VSAT system.

1) Confirmation of available communication methods for observation data transmission of the existing Automatic Weather Observation System
2) Confirmation of service area, fee, failure rate etc. of various communication services from the communication service providers in Sri Lanka
3) Implementation of transmission/reception experiment of observation data

IP-VPN has the advantages described below

Since an IP-VPN has some advantages such as "definition of routing path, quick fault detection and switching alternative path" as indicated in the following figure, an IP-VPN also gives subscribers stable and fast data communication. Although the data communication speed of the IP-VPN depends upon the number of users and frequency of use, the network speed is hardly significantly affected by the usage of other subscribers since an IP-VPN is only utilized by certain subscribers of the closed network of telecommunications carriers using Internet Protocol. Furthermore, it is possible to decrease the threat of cyber attacks due to the utilization of an IP-VPN.

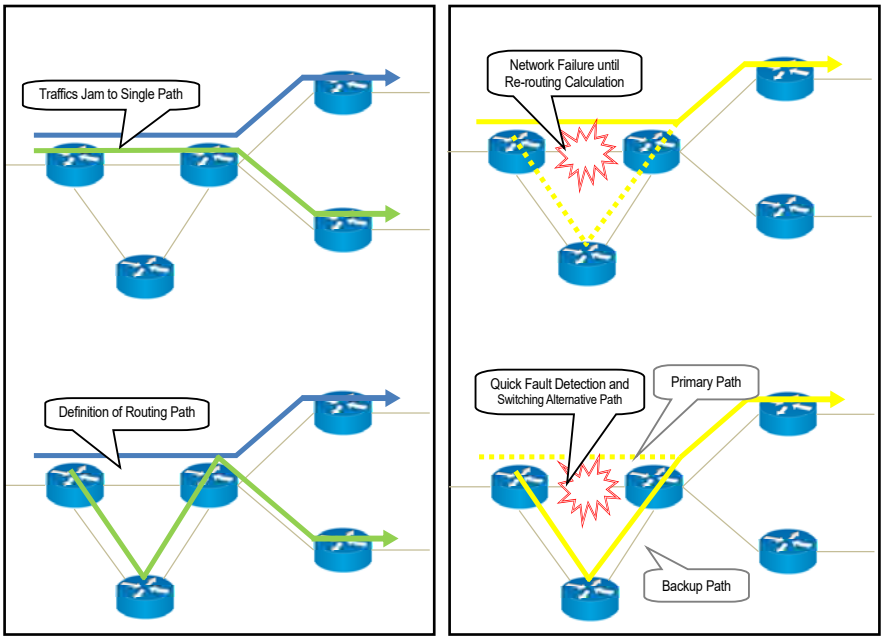


Figure 12: Definition of Routing Path and Quick Fault Detection & Switching Alternative Path

A system network configuration diagram before and after the change to the system network using IP-VPN is attached hereunder.

<Before> **<After>**

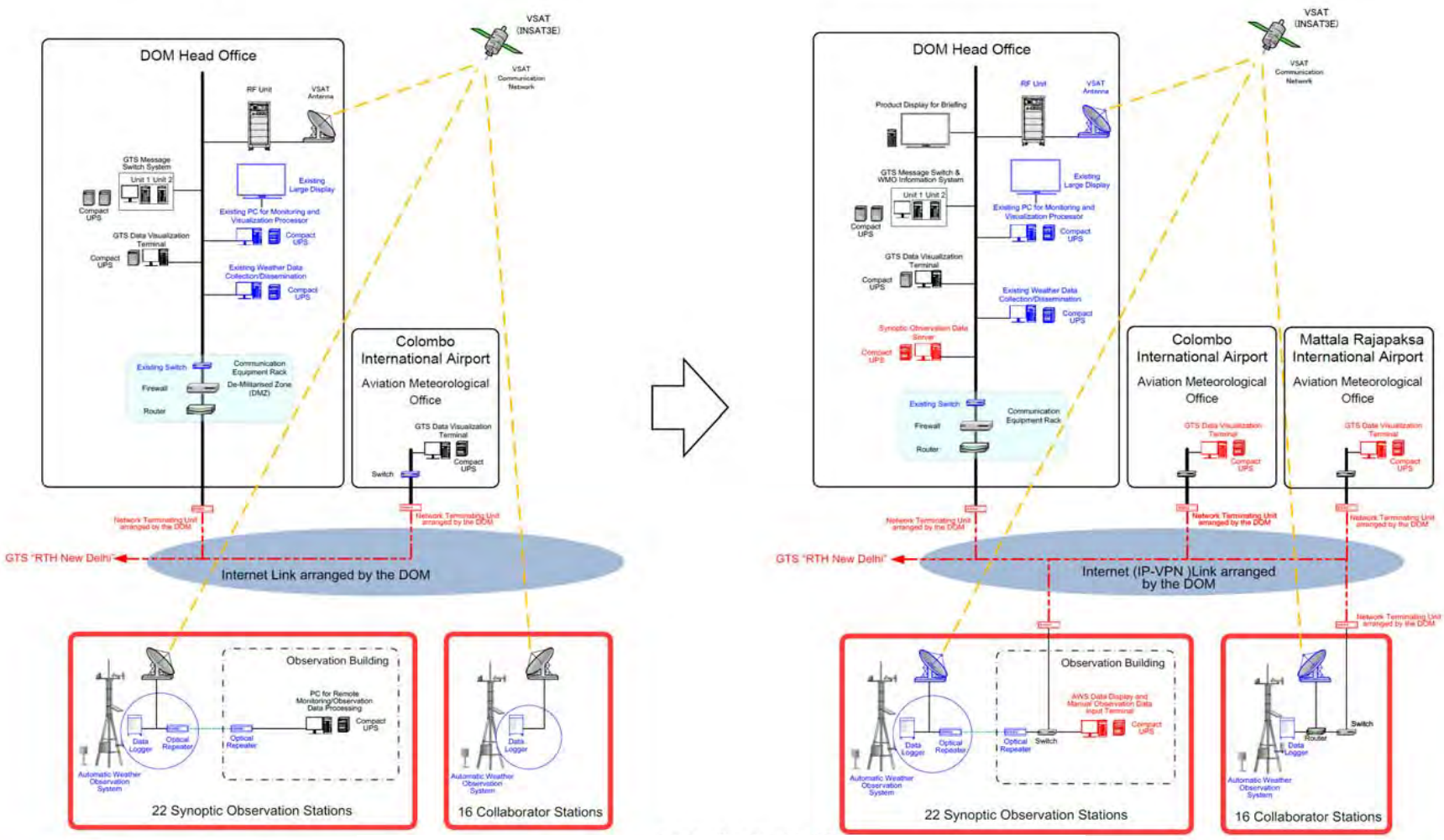


Figure 13: System Network Configuration Diagram

The required technical specifications for selecting an IP-VPN service provider and a procedure flow chart for transitioning from the VSAT system to IP-VPN attached below were prepared.

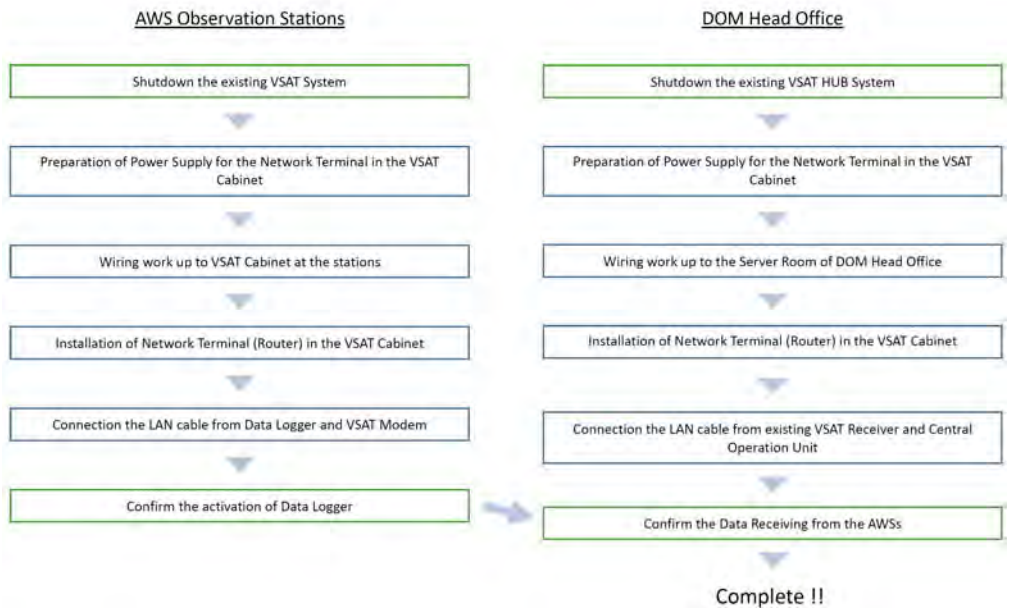


Figure 14: Operation Flow Chart for the Transition from VSAT to IP-VPN

<Review the current situation on GTS/MSS, and identify the issues to be improved>

- Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified.
  - Procurement of spare parts was difficult since the support period by the hardware (PC) manufacturer was already expired.
  - The exiting GTS/MSS did not support the BUFR format, which is the international meteorological code newly designated by the World Meteorological Organization (WMO), and recommended by the member countries.
- Baseline Survey Report was prepared and submitted to the JICA and the DOM.

<Replacement of the existing GTS Message Switch System>

Technical Specifications of a new GTS Message Switch System necessary for the procurement

procedures were prepared and the following equipment was procured by JICA. Equipment installation work and training completed on 18th December 2015.

- ✧ GTS Message Switch System
- ✧ Serial port Terminal Server
- ✧ Data Visualization Terminal
- ✧ Data Input Terminal
- ✧ Firewall Unit
- ✧ Compact Uninterruptible Power Supply

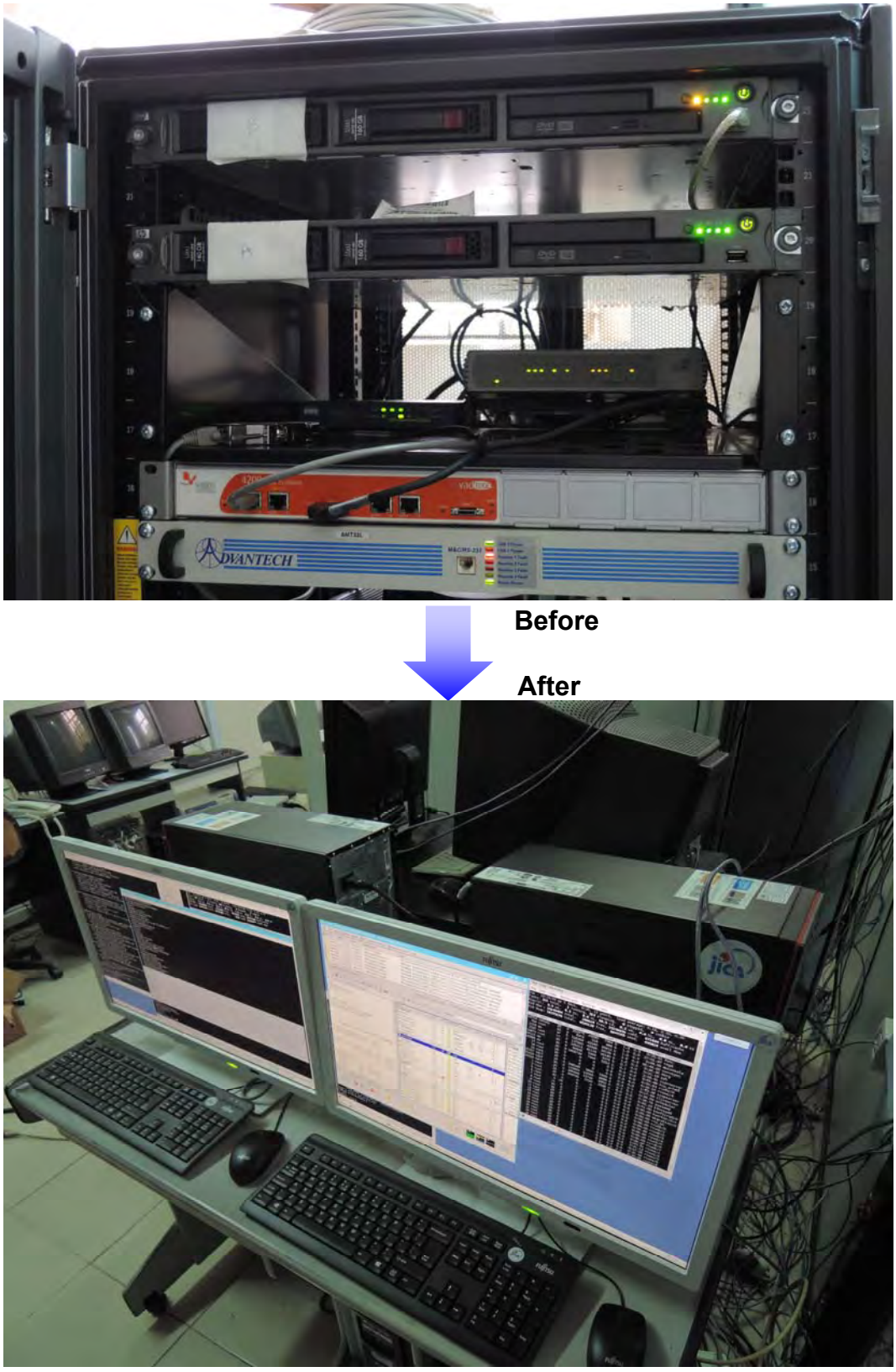
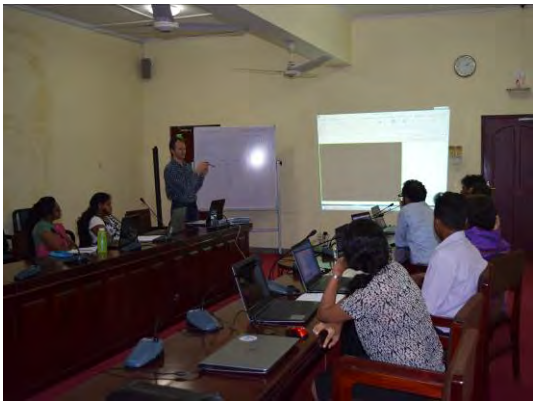


Figure 15: Replacement of the existing GTS Message Switch System

Training on the operation and maintenance of GTS Message Switch System by the equipment supplier engineers was implemented.



✧ First Training

Schedule: December 10 – December 18, 2015

Training Content: Operation and Maintenance of GTS Message Switch System

✧ Second Training

Schedule: May 02 – May 06, 2017

Training Content: Training on Operation of the Global Telecommunication System Message Switch (Visual Weather, Moving Weather module of the Global Telecommunication System Message Switch) and Access of WAFS (World Area Forecast System) data via the Secure SADIS FTP, BUFR Data Transmission

<Trainings for "Output 2"＞

Records of the trainings on the Output 2 are summarized in the following table.

Table 22: Training: Data Transmitting and Receiving Capacity

Date	Time	Venue	Attendee(s)	Conductor	Contents
January 21, 2015	9:30-12:00	Server Room	2	T. Endo	■ Trial System for AWS IP-VPN Connection
January 23, 2015	10:30-12:00	Electronics Engineer's Room	2	T. Endo	■ Technical Specification of GTS/MSS

July 09, 2015	15:00-16:00	Server Room	2	T. Endo	■ Stability Test of IP-VPN Connection
July 13, 2016	13:30-14:30	Electronics Engineer's Office	2	T. Endo	■ Discussion about Tender Document for new communication system of AWS
May 02, 2017	9:00-16:00	Conference Room	22	T. Endo Supplier's Engineer	■ Standard Operation and Setting method on the software module for GTS/MSS

<Remarks on "Output 2"＞

As a summary of the Output 2, the following table shows the items the DOM is able to implement under the Project and the items the DOM should solve/improve after completion of the Project.

Table 23: Remarks on "Output 2"

Output 2: Transmitting and receiving capacity of various kinds of meteorological data is strengthened.
Items the DOM is able to implement under the Project
■ To establish the stable real-time data transmission/reception of AWS observation data using IP-VPN in only about 10% data missing rate. (From January 2016 it became impossible to use the VSAT communication satellite, so it was not possible to receive observation data in real time from all the automatic weather observation systems except Colombo) ■ To receive meteorological data of the BUFR format recommended by the WMO to the member countries and utilize for weather forecasting
Items the DOM should solve/improve after completion of the Project
■ To connect the IP-VPN line between the DOM head office and all the automatic weather observation systems as soon as possible and to start receiving real-time observation data from the automatic weather observation system. ■ To record all troubles about GTS / MSS even if it is trivial content and utilize the record in the future trouble shooting

- Output 3: Capacity of weather forecasting is improved using obtained meteorological data.

Activities described in the PDM are as below.

3.1 Review the current situation on weather forecasting and identify the issues to be improved.
3.2 Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification.
3.3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations.
3.4 Produce weather forecast guidance of sea wind at the selected stations.
3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID).
3.6 Verify and improve the existing methods of seasonal forecast.
3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data.

Actual activities for Output 3 are described below.

<Review the current situation on weather forecasting and identify the issues to be improved>

- Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified.
  - Acquisition of the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka (DOM WRF) at the National Weather Center was impossible.
  - The DOM had no experience for production of Weather Forecast Guidance.
  - Weather forecasts of the DOM were qualitative (not quantitative).
  - Meteorological Satellite Images of Chinese Fengyun (FY) and Communication, Ocean and Meteorological Satellite (COMS) of Korea were directly received for forecasting (Japanese Meteorological Satellite, Himawari could not be received).
  - The Grid Point Value of the Numerical Weather Prediction (NWP) of Japan Meteorological Agency (JMA) was not received for forecasting.

- Number of the DOM personal who can operate Linux system was a few.
- Baseline Survey Report was prepared and submitted to the JICA and the DOM.

<Training for Weather Forecast Guidance>

In accordance with the figure attached on the right side, the production of Weather Forecast Guidance and the conduct of the required trainings are indicated hereunder

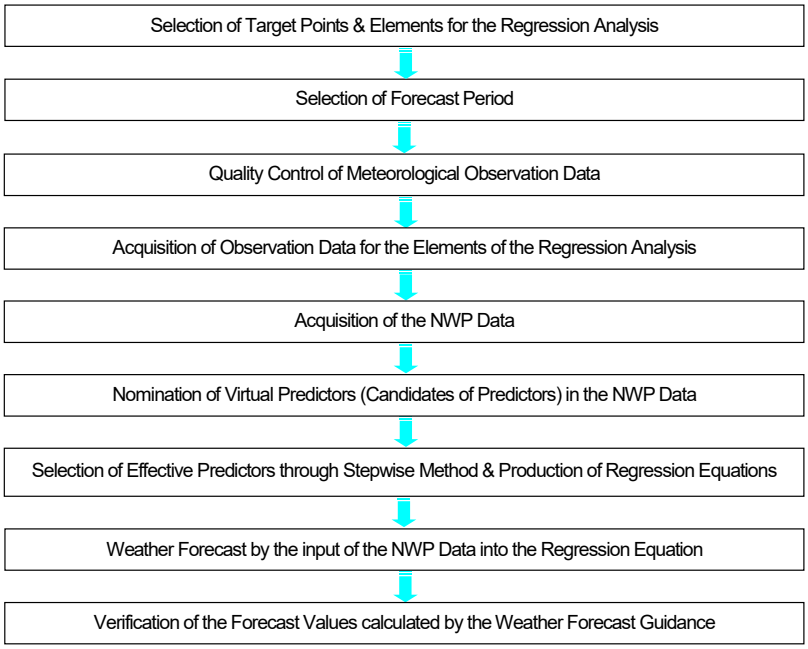


Figure 16: Production Procedures of Weather Forecast Guidance

In order to produce Weather Forecast Guidance and conduct the required trainings, the following technical specification of the equipment and software were obtained under the Project.

- Processor of the PC: Intel Core i7 or later
- Software required for the implementation of the Project:
  - Excel 2010 or later
  - Linux (CentOS6.5, Ubuntu 14.04.1)
  - gcc, gfortran, wgrib2
  - Virtual Machine (VMware Player, VMware Tools)

for the creation of the required environment for the production of Weather Forecast Guidance and the required trainings, the following support activities such as the installation

of the software in the PCs for Weather Forecast Guidance procured under the Project were made.

- Configuration of Excel for Regression Analysis
  - Selection of Excel Option and Add-In
  - Setting of Analysis Tool
  - Selection of Data Tab on the toolbar of Excel.
  - Click on Data Analysis to display the Regression Analysis tool.
- Download and save Linux (CentOS6.5) which is used for the development of program.
- Installation of the Virtual Machine (VMware Player) in Windows in order to use Linux.
  - Virtual Machine (VMware Player)
  - Download, installation and setup of VMware-player-6.0.1-1379776.exe (CPU: 2GHz or more, Memory: 2GB or more, Capacity of Hard disk: 100GB or more).
  - Installation and setup of the VMware Player (By executing the VMware Player's file, an installation wizard opens. Following the instructions of the wizard, set up the VMware player)
- Set-up of Linux (CentOS6.5 or Ubuntu 14.04.1 LTS 64 bits Desktop) and VMware Tools in the Virtual Machine on Windows.
  - Selection of "Production of New Virtual Machine" in the VMware Player.
  - To set the DVD which contains the file CentOS6.5 and to install the CentOS6.5 in a PC with Internet connection.
  - The software "VMware Tools" is automatically installed when connected to the Internet. In case there is no Internet connection, un-pack the packed file of VMware Tools and install the un-packed file.
- Installation of the wgrib2 file in order to decode files in grib2 format.
- Installation of Fortran to create the program for the Regression Analysis in Linux
- Installation of Perl in Linux (# yum install perl)

<Production of Weather Forecast Guidance>

In order to product Weather Forecast Guidance, the methods indicated in the following table were adopted.

Table 24: Methods for Production of Weather Forecast Guidance

Weather Forecast Guidance	Production of Regression Equation	Production of Weather Forecast Guidance	Method
Short Range and Weekly Weather Forecast Guidance	Grid Point Value of Numerical Weather Prediction & Observation Data	Grid Point Value of Numerical Weather Prediction substituted into the Regression Equation	MOS: Model Output Statistics
Seasonal Forecast Guidance	Grid Point Value of Reanalysis Data of Sea Surface Temperature & Observation Data	Grid Point Value of Numerical Weather Prediction (Sea Surface Temperature) substituted into the Regression Equation	PPM: Prefect Prognosis Method

<Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for precipitation was produced.

(1) Comparison between the DOM WRF Grid Point Vale and the GFS (NOAA Global Forecast System) for the Data Accuracy

Comparison of "Multiple Correlation Coefficient" and "Intercept" between the DOM WRF Grid Point Vale (GPV) and the GFS (NOAA Global Forecast System) Grid Point Vale (GPV) for the Data Accuracy with observation on data of the existing automatic weather observation systems (AWS) was implemented. In order to conduct the comparison indicated above, the following predictors of the DOM WRF Grid Point Vale (GPV) and the GFS (NOAA Global Forecast System) Grid Point Vale (GPV) were used.

- Wind Velocity: 850hPa and 200hPa
- Wind Shear: 500-600hPa, 400-700hPa, 400-600hPa, 300-850hPa, 300-700hPa, 300-600hPa, 300-500hPa, 300-400hPa and 200-600hPa
- Relative Humidity: 900hPa, 500hPa and 400hPa
- Precipitation: Surface

The results are as shown in the table below. According to the result, the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka (DOM WRF) was used for the Weather Forecast Guidance.

Table 25: Comparison of "Correlation Coefficient" and "Intercept" between the DOM WRF Grid Point Vale (GPV) and the GFS (NOAA Global Forecast System) for the Data Accuracy

	GPV of the Regional NWP Model (WRF) of Sri Lanka	GPV of GFS (NOAA Global Forecast System)
Multiple Correlation Coefficient	0.839	0.763
Intercept	9.966	10.979

(2) Grid Point Distance of the DOM WRF Grid Point Vale: 10km

(3) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC and 12UTC
- Real observation time corresponding to the forecast target time: 06:00 and 18:00 (Local Time of Sri Lanka)

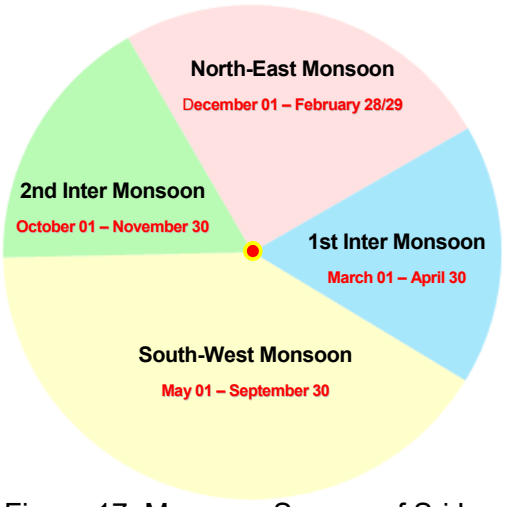


Figure 17: Monsoon Season of Sri Lanka

(4) Selected Forecast Point of the Weather Forecast Guidance: Colombo and Ratnapura

(5) As a result of analysis and examination, it was clarified that accuracy of Weather Forecast Guidance was improved by dividing into 4 Monsoon Seasons. For this reason, it was decided to carry out the Weather Forecast Guidance separately for each Monsoon Season shown in the right figure without setting the Weather Forecast Guidance to be one throughout the year.

Multiple Correlation Coefficient of the Weather Forecast Guidance to be one throughout

the year is as follows.

Table 26: Multiple Correlation Coefficient of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Colombo (one throughout the year)

	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
One throughout the year	0.45	0.41	0.36

Table 27: Multiple Correlation Coefficient of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Ratnapura (one throughout the year)

	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
One throughout the year	0.44	0.37	0.35

(6) The predictors that give the highest Multiple Correlation Coefficient were extracted by the developed program. Details of the predictors used for the Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation are shown in Annex 9.

(7) Confirmation of the accuracy of the Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation by dividing into 4 Monsoon Seasons

In order to confirm the accuracy of the Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation, Multiple Correlation Coefficient and Root Mean Square Error (RMSE) by dividing into 4 Monsoon Seasons were calculated. The results are as shown in the tables below.

Table 28: Multiple Correlation Coefficient of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
North-East Monsoon	0.52	0.59	0.52
1st Inter Monsoon	0.57	0.62	0.42
South-West Monsoon	0.90	0.43	0.54
2nd Inter Monsoon	0.66	0.69	0.62

Table 29: Multiple Correlation Coefficient of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
North-East Monsoon	0.50	0.45	0.45
1st Inter Monsoon	0.58	0.64	0.53
South-West Monsoon	0.64	0.55	0.49
2nd Inter Monsoon	0.55	0.54	0.57

Table 30: Root Mean Square Error (RMSE) of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
North-East Monsoon	8.5mm	2.6mm	8.8mm
1st Inter Monsoon	10.4mm	4.9mm	11.6mm
South-West Monsoon	4.5mm	6.3mm	3.9mm
2nd Inter Monsoon	8.0mm	7.5mm	8.3mm

Table 31: Root Mean Square Error (RMSE) of Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	12hours Precipitation Forecast	24hours Precipitation Forecast	36hours Precipitation Forecast
North-East Monsoon	8.3mm	9.0mm	5.8mm
1st Inter Monsoon	8.6mm	9.1mm	9.0mm
South-West Monsoon	6.1mm	10.6mm	7.2mm
2nd Inter Monsoon	7.9mm	11.3mm	7.8mm

In order to evaluate the accuracy of the data calculated by the Weather Forecast Guidance, the following comparisons among data of the Observation, the DOM WRF and the Weather Forecast Guidance with several real events more than 50mm/24h were conducted. The results of comparisons are indicated in the tables attached hereunder.

Table 32: Comparisons among Data of the Observation, the DOM WRF and the Weather Forecast Guidance

North East Monsoon

Event	Observation (mm/day)	DOM WRF (mm/day)	Weather Forecast Guidance (mm/24h)
10 Jan.2012	78.5	0	13.6
9 Jan 2013	52.0	35.8	31.0

1st Inter Monsoon

Event	Observation (mm/day)	DOM WRF (mm/day)	Weather Forecast Guidance (mm/24h)
10 Apr.2012	62.0	7.3	16.7
12 Apr.2012	62.0	9.3	22.7
15 Apr.2012	63.5	0.0	29.7
10 Apr 2013	54.5	5.1	14.9

South West Monsoon

Event	Observation (mm/day)	DOM WRF (mm/day)	Weather Forecast Guidance (mm/24h)
7 May 2013	125.5	73.7	125.5

2nd Inter Monsoon

Event	Observation (mm/day)	DOM WRF (mm/day)	Weather Forecast Guidance (mm/24h)
17 Oct.2011	55.0	4.0	8.7
1 Nov 2012	58.0	91.8	49.0

(8) Operation using the semi-automated Linux program for Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation was started.

As a result of verifying the forecast value by the short-term weather forecast guidance for Colombo rainfall (24 hours) between April 4, 2017 and July 18, 2017, the root mean square error between the forecast value and the observation value was 13.1 mm.

<Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance>

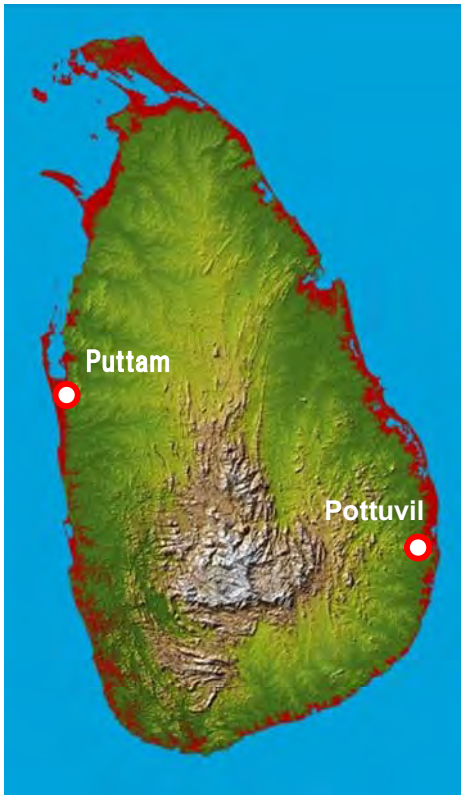
In accordance with the following procedures, the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance for precipitation was produced.

(1) Grid Point Distance of the DOM WRF Grid Point Vale: 10km

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Puttalam and Pottuvil



(4) As a result of analysis and examination, it was clarified that the accuracy of Weather Forecast Guidance was improved by dividing into 4 Monsoon Seasons. For this reason, it was decided to carry out the Weather Forecast Guidance separately for each Monsoon Season.

(5) The predictors that give the highest Multiple Correlation Coefficient were extracted by the developed program. Details of the predictors used for the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance are shown in Annex 9.

(6) Confirmation of the accuracy of the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance

In order to confirm the accuracy of the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance, Multiple Correlation Coefficient and Root Mean Square Error (RMSE) by dividing into 4 Monsoon Seasons were calculated. The results are as shown in the tables below.

Table 33: Multiple Correlation Coefficient of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Puttalam (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.64	0.56
1st Inter Monsoon	0.70	0.63
South-West Monsoon	0.73	0.72
2nd Inter Monsoon	0.68	0.65

Table 34: Multiple Correlation Coefficient of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Pottuvil (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.75	0.70
1st Inter Monsoon	0.74	0.67
South-West Monsoon	0.65	0.69
2nd Inter Monsoon	0.69	0.74

Table 35: Root Mean Square Error (RMSE) of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Puttalam (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.6m/s	0.6m/s
1st Inter Monsoon	0.5m/s	0.6m/s
South-West Monsoon	0.4m/s	0.4m/s
2nd Inter Monsoon	0.7m/s	0.7m/s

Table 36: Root Mean Square Error (RMSE) of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Pottuvil (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.5m/s	0.5m/s
1st Inter Monsoon	0.7m/s	0.7m/s
South-West Monsoon	1.3m/s	0.9m/s
2nd Inter Monsoon	0.8m/s	0.7m/s

<Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation was produced.

(1) Grid Point Distance of the GFS (NOAA Global Forecast System) Grid Point value: 0.5 degree

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Colombo and Ratnapura

(4) As a result of analysis and examination, it was clarified that the accuracy of Weather Forecast Guidance was improved by dividing into 4 Monsoon Seasons. For this reason, it was decided to carry out the Weather Forecast Guidance separately for each Monsoon Season.

(5) The predictors that give the highest Multiple Correlation Coefficient were extracted by the developed program. Details of the predictors used for the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation are shown in Annex 9.

(6) Confirmation of the accuracy of the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation

In order to confirm the accuracy of the Weekly (144h-168h ahead) Weather Forecast

Guidance for Precipitation, Multiple Correlation Coefficient and Root Mean Square Error (RMSE) by dividing into 4 Monsoon Seasons were calculated. The results are as shown in the tables below.

Table 37: Multiple Correlation Coefficient of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	0.44
1st Inter Monsoon	0.32
South-West Monsoon	0.353
2nd Inter Monsoon	0.33

Table 38: Multiple Correlation Coefficient of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	0.40
1st Inter Monsoon	0.44
South-West Monsoon	0.46
2nd Inter Monsoon	0.26

Table 39: Root Mean Square Error (RMSE) of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	9.9mm
1st Inter Monsoon	14.0mm
South-West Monsoon	※
2nd Inter Monsoon	※

※ RMSE figure shall be calculated after the project completion as the relevant data is currently not available yet as of this time.

Table 40: Root Mean Square Error (RMSE) of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	8.6mm
1st Inter Monsoon	11.3mm
South-West Monsoon	※
2nd Inter Monsoon	※

※ RMSE figure shall be calculated after the project completion as the relevant data is currently not available yet as of this time.

<Seasonal Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Seasonal Weather Forecast Guidance for Precipitation was produced.

(1) Grid Point Distance of the CFS (NOAA Climate Forecast System) Grid Point value: 0.5 degree

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Colombo and Ratnapura

(4) The predictors used for the Seasonal Weather Forecast Guidance for Precipitation

Sea Surface Temperature (SST) up to 9 months ahead of the NOAA Climate Forecasting System at 5 points indicated on the map below.

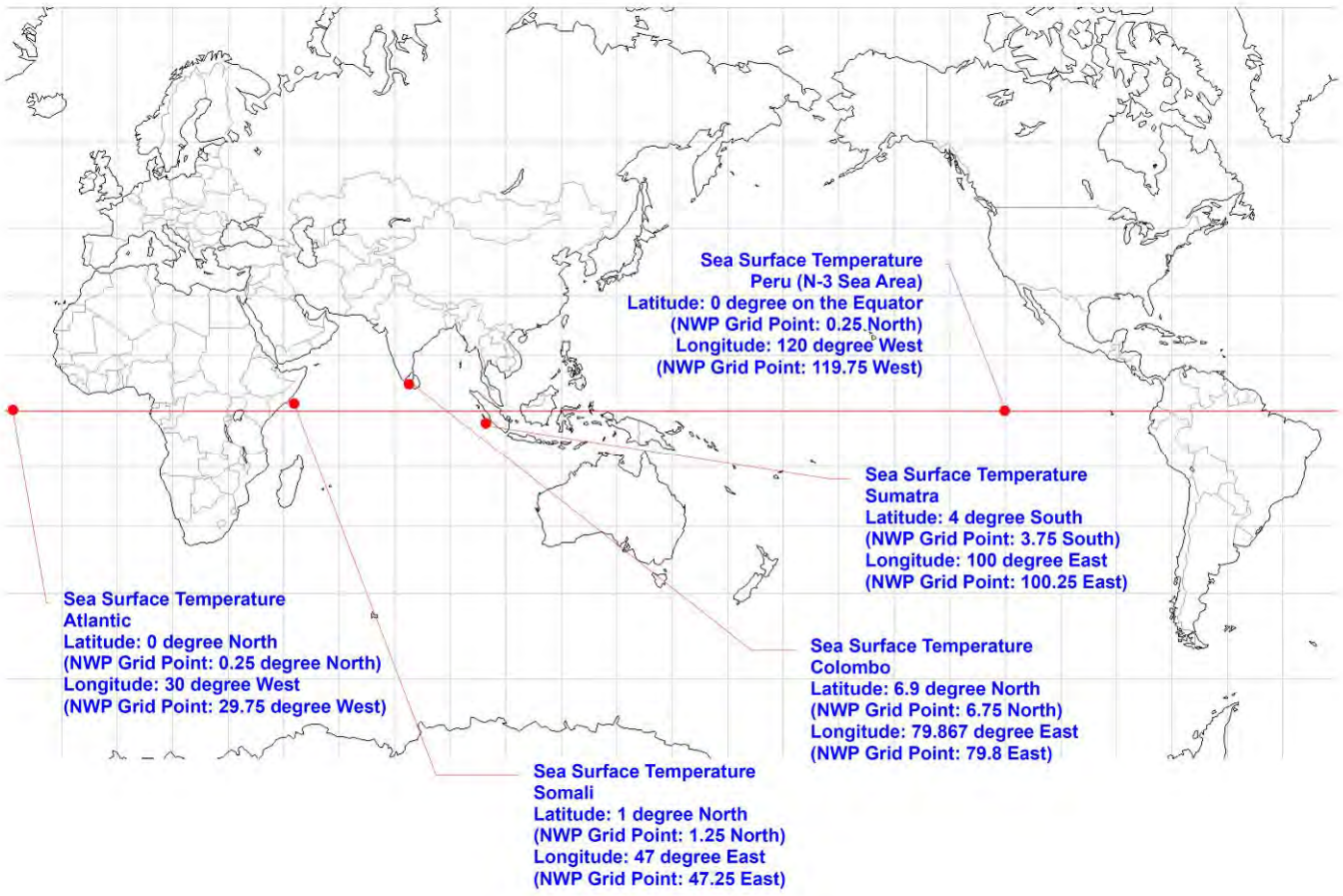
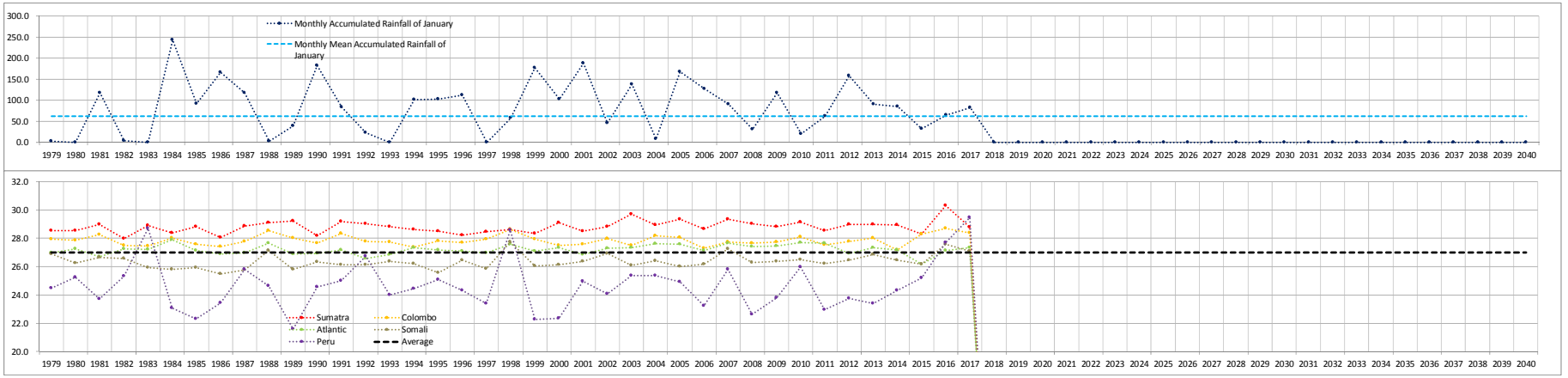


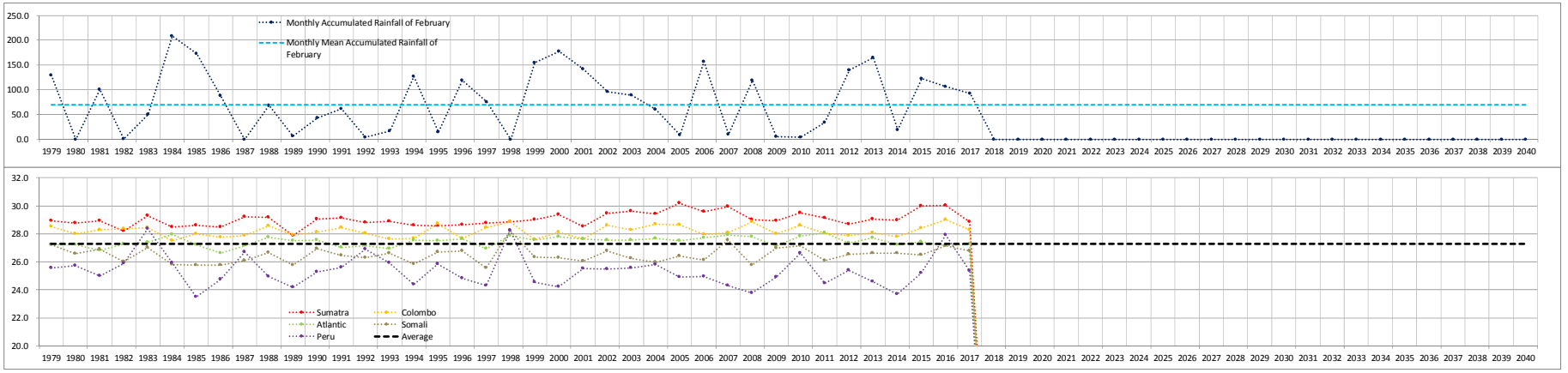
Figure 18: 5 points of Sea Surface Temperature (SST) up to 9 months ahead of the NOAA Climate Forecasting System

(5) Annual variation of Monthly Mean Accumulated Rainfall at Colombo and Monthly Mean Sea Surface Temperatures (SST) at 5 Points in the World

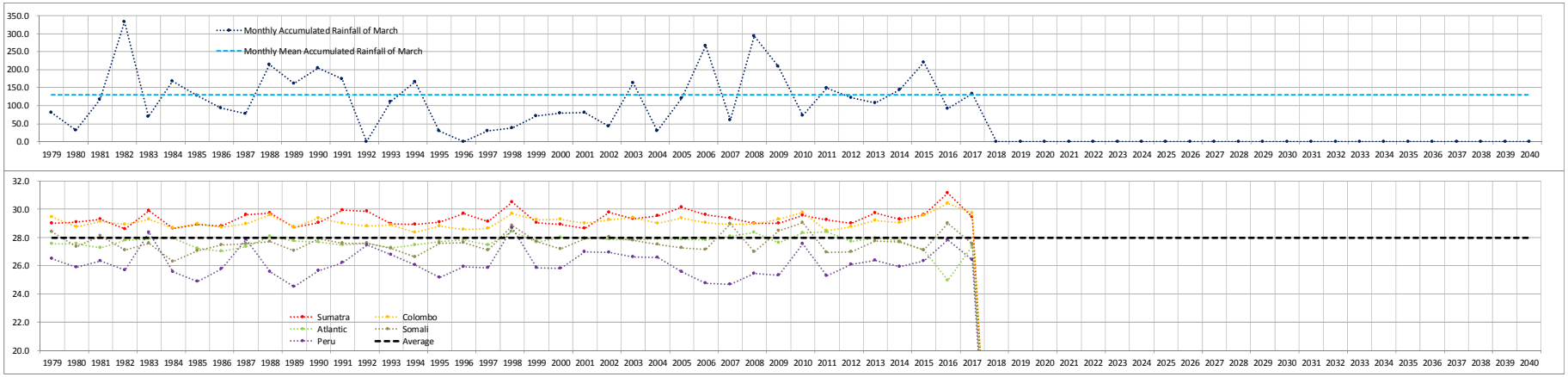
January



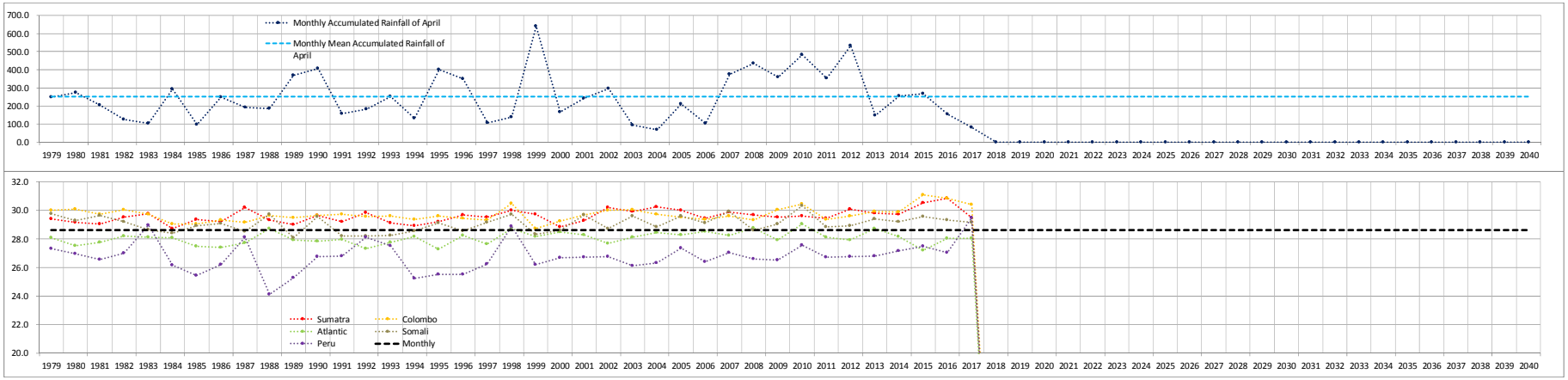
February



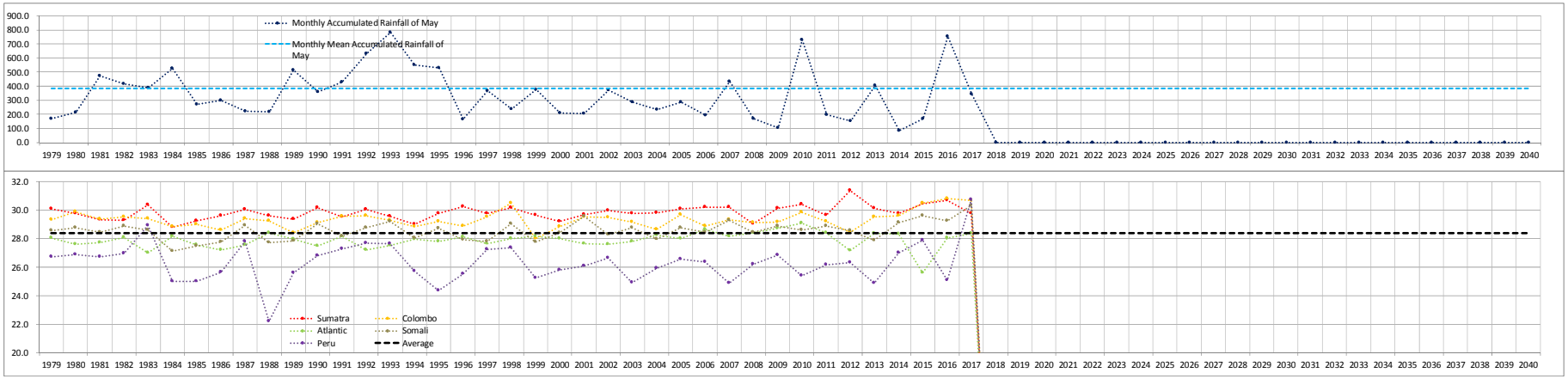
March


Monthly Accumulated Rainfall of March
Monthly Mean Accumulated Rainfall of March
Sumatra
Colombo
Atlantic
Somali
Peru
Average

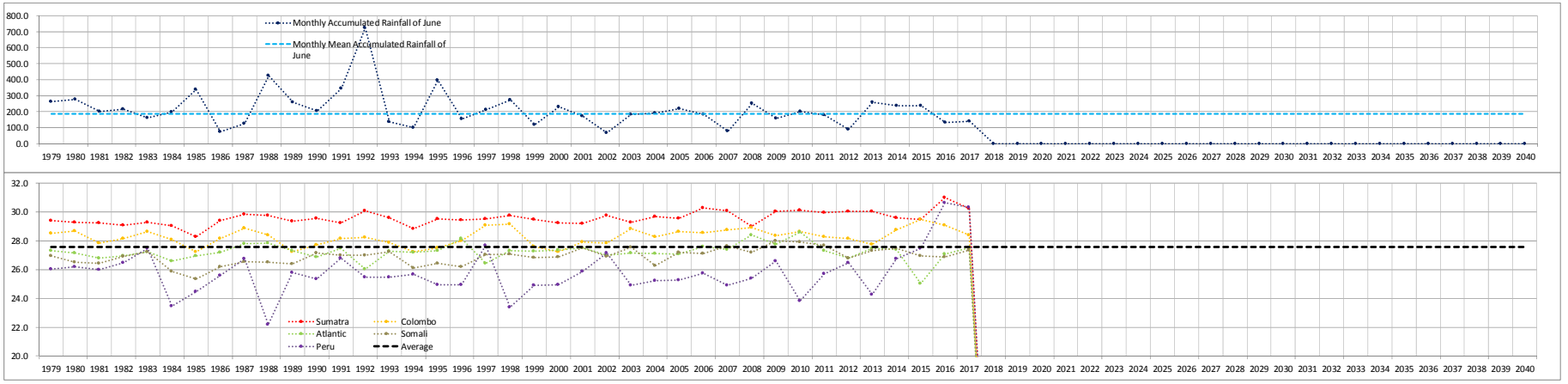
April


Monthly Accumulated Rainfall of April
Monthly Mean Accumulated Rainfall of April
Sumatra
Colombo
Atlantic
Somali
Peru
Monthly

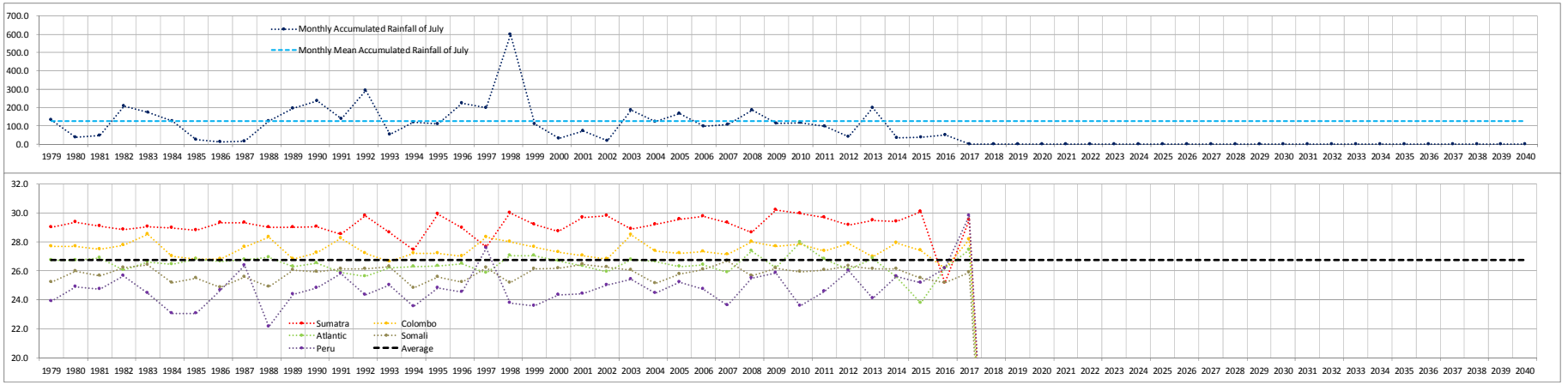
May


Monthly Accumulated Rainfall of May
Monthly Mean Accumulated Rainfall of May
Sumatra
Colombo
Atlantic
Somali
Peru
Average

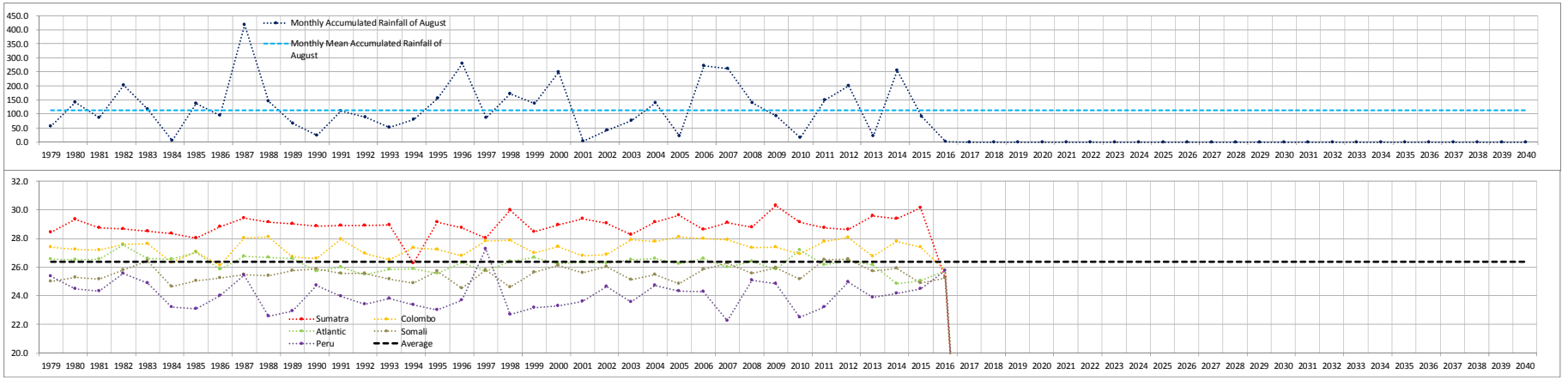
June


Monthly Accumulated Rainfall of June
Monthly Mean Accumulated Rainfall of June
Sumatra
Colombo
Atlantic
Somali
Peru
Average

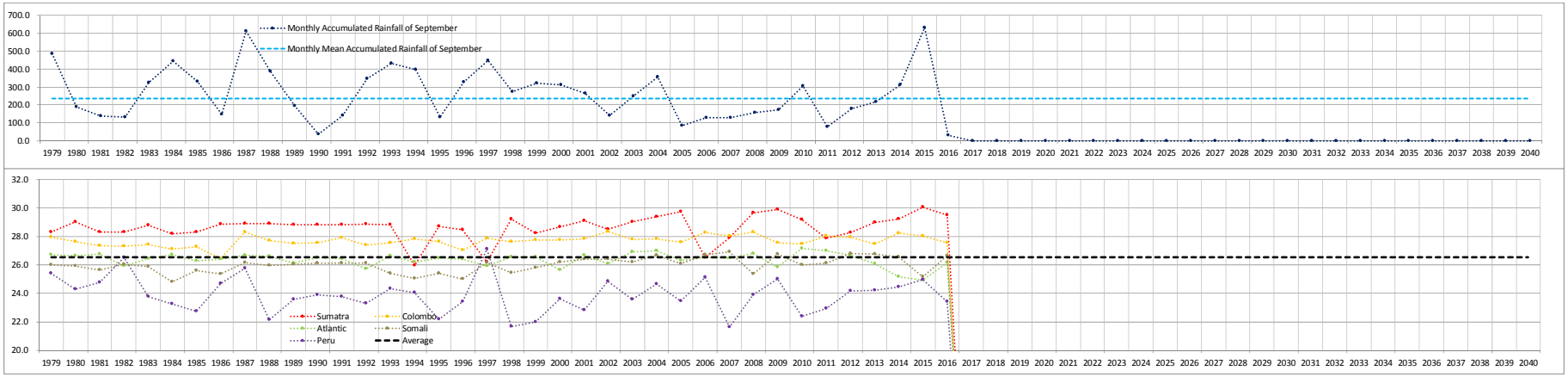
July


Monthly Accumulated Rainfall of July
Monthly Mean Accumulated Rainfall of July
Sumatra
Colombo
Atlantic
Somali
Peru
Average

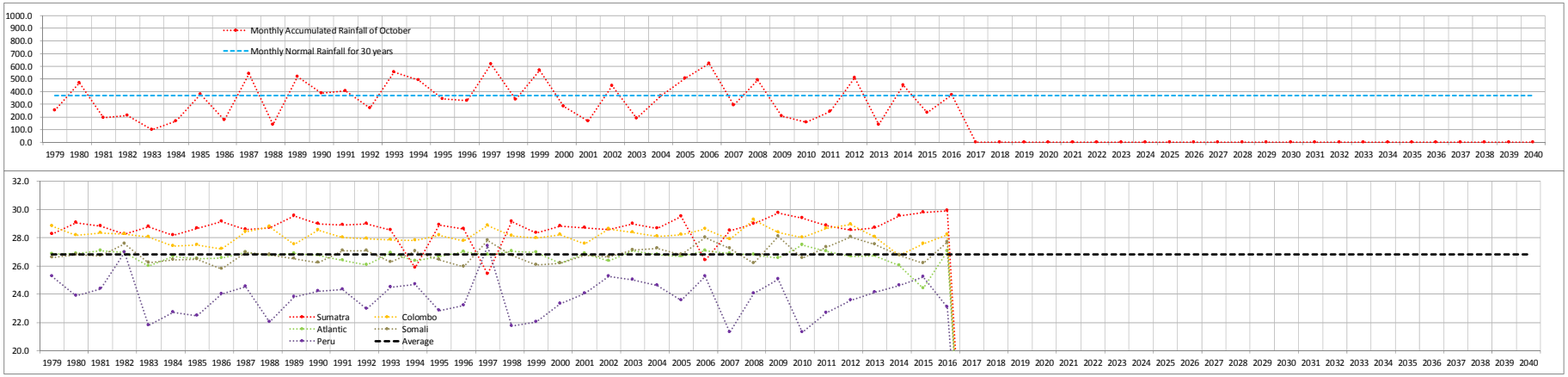
August


Monthly Accumulated Rainfall of August
Monthly Mean Accumulated Rainfall of August
Sumatra
Colombo
Atlantic
Somali
Peru
Average

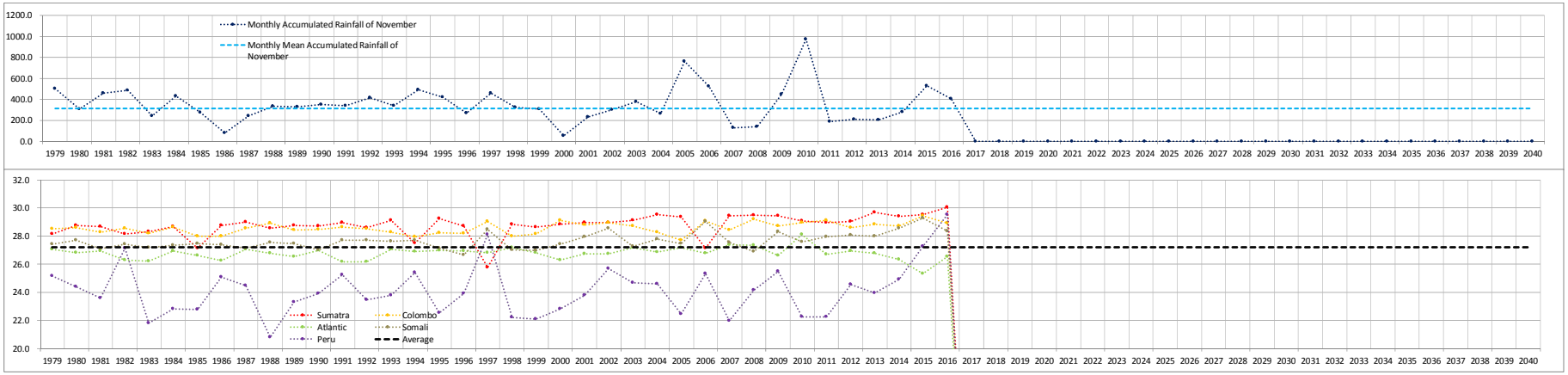
September



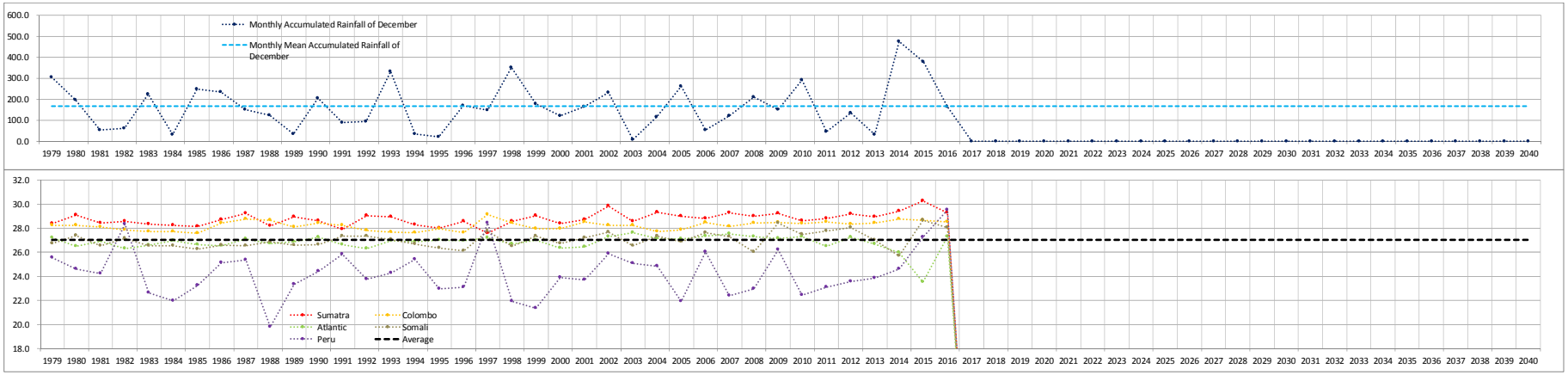
October



November



December



<Conduct training on Satellite Animation and Interactive Diagnosis (SATAID)>

The "SATAID training" was aiming for the forecaster and meteorologists of DOM to acquire the skill to make analysis of the tropical weather using satellite and numerical weather prediction data which are provided from the HimawariCast receiver and the JMA GSM data. In advance of the "SATAID training", the "lecture on the basic meteorology" by the long-term expert and the "theoretical/operation tropical meteorology trainings" by the short-term experts were conducted (Photo 3-4). It was ensured that the forecasters and meteorologists who attended these lecture and trainings have acquired the skill from the results of the tests and inquiries after the lecture and trainings.

Photo 3-4 Participants in "Lecture on basic meteorology", "Training on theoretical tropical meteorology" and "Training on operational tropical meteorology" (from left to right).

<Monitoring of Weather Forecasts>

- Discussions with the DOM on the preparation and issuance of Weather Forecasts were conducted.
- Contents of the weather briefings of the DOM were improved with various kinds of data from Overseas, meteorological satellite data of Himawari (a Japanese meteorological satellite), products of the DOM WRF.

<Trainings for "Output 3">

(1) Trainings conducted by the Consultant Team

Records of the trainings on the Output 3 are summarized in the following table.

Table 41: Training: Weather Guidance

Date	Time	Venue	Attendee(s)	Conductor	Contents
January 19, 2015	14:00-16:00	Conference Room	11	Y. Uchida N. Noguchi T. Endo	■ PCs Configuration ■ Weekly 168h Rain Weather Forecast Guidance
January 20, 2015	16:30-18:30	Forecasting Centre	1	Y. Uchida N. Noguchi	■ Weekly 168h Rain Weather Guidance
January 21, 2015	09:00-10:30	Conference Room	5	Y. Uchida N. Noguchi	■ Weather Forecast Guidance Introduction & Basic Knowledge, Feature of WRF (NWP Model)
January 23, 2015	09:00-10:45	Conference Room	9	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance
January 27, 2015	14:00-16:00	Conference Room	8	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance
January 29, 2015	09:30-11:00	Conference Room	7	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Guidance (Point to Point & Point to Mesh: approx.60km) ■ Weekly 168h Rain Weather Guidance
January 29, 2015	14:00-15:30	Forecasting Centre	2	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance
January 30, 2015	09:30-11:00	Conference Room	7	Y. Uchida N. Noguchi	■ Required Procedures for Weather Forecast Guidance ■ Sea Wind Weather Guidance
July 02, 2015	10:30-12:00	Conference Room	5	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon, South-West Monsoon)
July 07, 2015	09:30-11:30	Conference Room	5	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon, South-West Monsoon)
July 10, 2015	10:45-11:15	Conference Room	6	Y. Uchida N. Noguchi	■ 12, 24 and 36h Rain Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon,

					South-West Monsoon) for the routine work
May 04, 2016	09:00-12:30	National Meteorological Center (NMC)	8	Y. Uchida N. Noguchi M. Yamauchi	■ Seasonal Weather Forecast Guidance by PPM (Prefect Prognosis Method)
May 04, 2016	13:30-16:30	National Meteorological Center (NMC)	8	Y. Uchida N. Noguchi M. Yamauchi	■ Seasonal Weather Forecast Guidance by PPM (Prefect Prognosis Method)
November 16, 2016	08:30-10:00	National Meteorological Center (NMC)	6	Y. Uchida N. Noguchi M. Yamauchi	■ Weekly Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon, South-West Monsoon)
November 17, 2016	08:30-10:00	National Meteorological Center (NMC)	4	Y. Uchida N. Noguchi M. Yamauchi	■ Weekly Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon, South-West Monsoon)
November 17, 2016	08:30-10:00	National Meteorological Center (NMC)	4	Y. Uchida N. Noguchi M. Yamauchi	■ Weekly Weather Forecast Guidance (1st Inter Monsoon, 2nd Inter Monsoon, North-East Monsoon, South-West Monsoon)
March 16, 2017	14:00-15:00	National Meteorological Center (NMC)	2	N. Noguchi T. Endo	■ PCs Configuration (Installation & Initial Settings of Linux OS on Virtual Machine)
March 17, 2017	14:30-15:30	National Meteorological Center (NMC)	2	N. Noguchi T. Endo	■ PCs Configuration (Installation & Initial Settings of Linux OS on Virtual Machine)
March 22, 2017	14:00-15:30	National Meteorological Center (NMC)	4	N. Noguchi T. Endo	■ Weekly Weather Forecast Guidance (Download and import procedure of GFS data)
March 28, 2017	14:00-15:30	National Meteorological Center (NMC)	5	Y. Uchida N. Noguchi T. Endo	■ Weekly Weather Forecast Guidance (Download and import procedure of GFS data)
March 29, 2017	14:00-15:00	National Meteorological Center (NMC)	5	Y. Uchida N. Noguchi T. Endo	■ Seasonal Weather Forecast Guidance (Download and import procedure of GFS data)

April 28, 2017	14:00-15:00	National Meteorological Center (NMC)	2	Y. Uchida N. Noguchi T. Endo	■ Installation and Operation of Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours precipitation) Weather Forecast Guidance with the WRF Grid Point Vale

(2) Trainings conducted by the long-term expert and short-term experts

- Lecture on basic meteorology

  Since universities in Sri Lanka have no meteorological class, it is difficult for DOM staff to obtain the knowledge of meteorology. Based on the request from the DOM, the long-term expert started the weekly lecture on basic meteorology for 24 forecasters and meteorologists of DOM in January 2015 and finished it in August 2016. The participants in the lecture have obtained the basics of meteorology of the level from the undergraduate to the first grade of graduate.
- Training on theoretical tropical meteorology

  The short-term expert of JAMSTEC implemented the training on the latest theories concerning the tropical meteorology.
- Training on operational tropical meteorology

  The short-term expert of JMA implemented the training on the operational skill of the tropical meteorology using JRA-55 reanalysis data and its analysis tool “iTacs”.
- Training on SATAID

  The training was conducted as described in <Training of the Satellite Animation and Interactive Diagnosis (SATAID)>
- Training on "QPE" and "QPF"

  In the project seminar "Next Generation Weather Services for Rainfall Disaster Mitigation in Sri Lanka" on 25 July 2017, two short-term experts made presentation on the theories and technologies necessary for disseminating weather information against disasters induced by heavy rainfall. In DOM, they also conducted trainings with the same contents as the seminar for forecasters and meteorologists of DOM. The trainees

Photo 3-5 Trainings of “QPE” and “QPF”

have understood the importance of on-line QPE and QPF at flooding or landslide events.

(3) Voluntary lectures by the Japanese Researcher (Arranged by the Long-term Expert)

The DOM staff have little opportunity to touch with latest meteorology. Four voluntary lectures were held by Japanese meteorological researchers, who visited Sri Lanka, so that the DOM staff could learn latest meteorology (Photo 3-6). Table 41 shows the list of the lectures.

Table 42 Voluntary lectures by Japanese meteorological researcher

Lecture	Name	Position	Date
Digital Climate Rainfall Map	Prof. Akiyo YATAGAI	Nagoya University	16 Jan. 2017
Characteristics of Rainfall in the Tropics	Prof. Taichi HAYASHI	Kyoto University	23 July 2015
Short course of Cloud Physics	Prof. Yasushi FUJIYOSHI	Hokkaido University	7 Dec. 2015
GPS Meteorology	Prof. Toshihito TSUDA	Kyoto University	26 Feb. 2017

Photo 3-6 Voluntary lectures by Prof. Yatagai, Prof. Hayashi, Prof. Fujiyoshi and Prof. Tsuda.

<Remarks on “Output 3”>

As a summary of the Output 3, the following table shows the items the DOM is able to implement under the Project and the items the DOM should solve/improve after completion of the Project.

Table 43: Remarks on "Output 3"

Output 3: Capacity of weather forecasting is improved using obtained meteorological data.
Items the DOM is able to implement under the Project
■ To make forecast guidance based on MOS (Model Output Statistics) method for short-range forecast and weekly forecast using forecast values and corresponding observation values. ■ To calculate short-range precipitation forecast guidance quasi-automatically for improving efficiency of short-range precipitation forecasting work. ■ To make regression equation for the quantitative seasonal forecast by the PPM (Perfect Prognosis Method) method, using the monthly average sea surface temperature in the tropical 5 points (western part of Indian Sea, Colombo, Sumatra, west of Peru, central part of Atlantic Ocean) and the monthly precipitation in Colombo. ■ To make Excel program for reducing numerous meteorological elements picked up initially to the appropriate numbers of meteorological elements for stability of prediction by regression equation. ■ To download the grid point value data file of the global model with grib2 compressed file format and to unpack the grib2 compressed file using Linux wgrib2 software. ■ To make a regression equation for the short-range forecast of precipitation using characteristics that precipitation depends on the season in Sri Lanka such as regression equations for northeast monsoon, first inter-monsoon, southwest monsoon, and second inter-monsoon. To improve the accuracy of short-term forecast using the seasonal division comparing with seasonal division and without seasonal division. ■ To implement weekly precipitation forecasts at Colombo and Ratnapura divided seasonally by MOS method. ■ To use RMSE (Root Mean Square Error) as a verification of accuracy for quantitative forecast.
Items the DOM should solve/improve after completion of the Project
■ To continuously review the most suitable weather forecast guidance for Sri Lanka After implementing the weather forecast guidance under this project, the grid point values of the improved numerical forecasting model below are available and, in the future, it is expected that the lattice point values of a more accurate numerical weather forecast models will be made public. Therefore, instead of the 0.5 degree grid point value of the currently used NOAA GFS (Global Forecast System), the grid point values of the newly available numerical prediction model are used as the initial condition and boundary condition of the WRF model and it was compared with the forecast results of the weather forecast guidance prepared in this project. <Grid point values for newly available short-range forecast and weekly forecast> GSM: Japan (JMA) wide area model, lattice spacing: 0.25 degree, data assimilated GFS: Wide region model of the USA (NOAA), lattice spacing: 0.25 degree, data assimilated IFS: EC (ECMWF) wide area model, two types with lattice spacing of 8 km, data assimilated ■ To continuously verify the forecast accuracy of the WRF model through the comparison of the weather forecast guidances that directly uses the grid point values of the newly available numerical

weather forecast model without using the WRF model and the weather forecast guidance using the DOM WRF model.

- To prepare the program to automatically acquire data and build a large capacity data storage system to store the acquired data since the labor and the amount of data are enormous. In order to develop the accuracy of the weather forecast guidance to a higher level, it is necessary to continuously acquire and store grid point values (forecast values) to be used from the meteorological organizations of each country for as long as possible (at least 2 years).
- To develop a program to accurately select optimal meteorological elements (predictors) from several meteorological elements of the numerical forecast model in order to shorten the time required for the development of a new weather forecast guidance and to improve the accuracy of rainfall guidance.
- To change from the multiple regression weather forecast guidance to the Kalman filter weather forecast guidance which can reflect error between observation data and forecasting data quickly after the conduct of the comparative studies of weather forecast guidance using various numerical weather forecasting models and the determination of the optimal numerical forecasting model & predictor for weather forecast in Sri Lanka.
- To improve skills related to the operation of computer programs using Linux in order to maintain various automatic programs necessary for weather forecast guidance operation.
- To increase the number of surface weather stations with the AWS to improve the accuracy of forecast and accuracy evaluation of the forecast.

Output 4: Warning criteria is elaborated.

Activities described in the PDM are as below.

4.1 Review the current situation on warnings, and identify the areas to be improved.

4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning strike.3.1Review the current situation on weather forecasting and identify the issues to be improved.

Actual activities for Output 4 are described below.

<Review the current situation on weather forecasting and identify the issues to be improved>

- Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified.
  - Current issuance of advisory/warning is universally applied all over the country using the same criteria.
  - The advisory/warning signs are not comprehensible for the public.
  - The advisory/warning bulletin is mainly stated as textual information and difficult.
- Baseline Survey Report was prepared and submitted to the JICA and the DOM.

<Preparation of New advisory/warning criteria of heavy rain/strong wind and advisory criteria for lightning>

- Collection of weather observation data and disaster events has been conducted.
- Introduction of JMA advisory and warning has been made.
- Existing advisory/warning criteria of heavy rain and strong wind have been verified using weather observation data and disaster information.
- Revised advisory/warning criteria for heavy rainfall have been set at each climatic/geographical zone.

(1) Approach 1: Statistical analysis using both the disaster records and AWS/rain gauge rainfall data. (Using disaster events whose locations are within 10km from the nearest

AWS/rain gauge)

Data used for the analysis:

- AWS rainfall data (hourly) at thirty-eight (38) SYNOP and AWS stations.
- Rain gauge rainfall data (daily) at about three hundred (300) stations.
- Disaster events recorded by the DMC (death toll due to flood, landslide and cyclone): 462 events.

Period in scope of the analysis:

January 1978 to December 2014

Method:

- Extract disaster events due to flood: 462 →199 events.
- Extract disaster events whose locations are within 10km from the nearest AWS/rain gauge: 199 →114 events.
- Extract maximum daily rainfall observed by the AWS/rain gauge during the 5 days prior to the occurrence of each disaster.
- Classify the AWS/rain gauge stations into two climate zones: Dry Zone and Wet + Intermediate Zone
- Sort the extracted AWS/rain gauge daily rainfall data in descending order for the two climate zones.
- Assume the 40th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the 50th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone:	Advisory > 70mm/24h + 50mm/6h
	Warning > 100mm/24h
Criteria for Wet + Intermediate Zone:	Advisory > 100mm/24h + 50mm/6h
	Warning > 120mm/24h

(2) Approach 2: Statistical analysis using both the disaster records and AWS/rain gauge rainfall data. (Without considering the distance between the place where the disaster occurred and the nearest AWS/rain gauge)

Data used for the analysis:

- AWS rainfall data (hourly) at thirty-eight (38) SYNOP and AWS stations.
- Rain gauge rainfall data (daily) at about three hundred (300) stations.
- Disaster events recorded by the DMC (death toll due to flood, landslide and cyclone): 462 events.

Period in scope of the analysis:

January 1978 to December 2014

Method:

- Extract disaster events due to flood: 462 →199 events.
- Extract maximum daily rainfall observed by the AWS/rain gauge during the 5 days prior to the occurrence of each disaster.
- Classify the AWS/rain gauge stations into two climate zones: Dry Zone and Wet + Intermediate Zone
- Sort the extracted AWS/rain gauge daily rainfall data in descending order for the two climate zones.
- Assume the 40th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the 50th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone:	Advisory > 70mm/24h + 50mm/6h
	Warning > 100mm/24h
Criteria for Wet + Intermediate Zone:	Advisory > 90mm/24h + 50mm/6h
	Warning > 120mm/24h

(3) Approach 3: Statistical analysis using AWS/rain gauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning/advisory.)

Data used for the analysis:

- Before the operation of the AWS:
- Rain gauge rainfall data (daily) at selected twenty (20) SYNOP stations.

- After the operation of the AWS:
- AWS rainfall data (hourly) at selected twenty (20) stations co-located at the SYNOP stations.

Period in scope of the analysis:

January 1978 to December 2014

Method:

- Sort all the daily rainfall data during the period in scope of the analysis in descending order for each SYNOP station.
- Extract the 95th percentile of the daily rainfall data for each SYNOP station.
- Extract the 99th percentile of the daily rainfall data for each SYNOP station.
- In case daily rainfall data is missing (-999) or daily rainfall is below 0.1mm/24h, those data are not included in the statistical analysis.
- Classify the SYNOP stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Assume the area-averaged 95th percentiles of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the area-averaged 99th percentiles of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone:	Advisory > 55mm/24h	
	Warning > 100mm/24h	
Criteria for Wet + Intermediate Zone:	Advisory > 45mm/24h	
	Warning > 85mm/24h	

(4) Approach 4: Statistical analysis using AWS/rain gauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning/advisory.)

Data used for the analysis:

- Before the operation of the AWS:
- Rain gauge rainfall data (daily) at selected twenty (20) SYNOP stations.
- After the operation of the AWS:

- AWS rainfall data (hourly) at selected twenty (20) stations co-located at the SYNOP stations.

Period in scope of the analysis:

January 1978 to December 2014

Method:

- Sort all the daily rainfall data during the period in scope of the analysis in descending order for each SYNOP station. (Same as Method 1 of Approach No. 3)
- Extract the 95th percentile of the daily rainfall data for each SYNOP station.
- Extract the 99th percentile of the daily rainfall data for each SYNOP station.

  * In case daily rainfall data is missing (-999) or daily rainfall is below 0.1mm/24h, those data are not included in the statistical analysis.
- Classify the SYNOP stations into two geographical areas: Mountain area and Plain area.
- Assume the area-averaged 95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain advisory.
- Assume the area-averaged 99th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Mountain Area: Advisory > 35mm/24h
Warning > 65mm/24h
Criteria for Plain Area: Advisory > 50mm/24h
Warning > 100mm/24h

Prospective Warning Criteria (Heavy Rain)

Climatic Zone	Approach No.1 Criteria (Disaster Event Analysis)	Approach No.2 Criteria (Disaster Event Analysis)	Approach No.3 Criteria (Statistical Analysis)	Approach No.4 Criteria (Statistical Analysis)	Geographical Area
Wet Zone + Intermediate Zone	Advisory R > 50mm/6h & R > 100mm/24h	Advisory R > 50mm/6h & R > 90mm/24h	Advisory R > 45mm/24h	Advisory R > 35mm/24h	Mountain Area
	Warning R > 120mm/24h	Warning R > 120mm/24h	Warning R > 85mm/24h	Warning R > 65mm/24h	
Dry Zone	Advisory R > 50mm/6h & R > 70mm/24h	Advisory R > 50mm/6h & R > 80mm/24h	Advisory R > 55mm/24h	Advisory R > 50mm/24h	Plain Area
	Warning R > 100mm/24h	Warning R > 90mm/24h	Warning R > 100mm/24h	Warning R > 100mm/24h	

	Existing Criteria
Whole Country	Advisory R > 50mm/6h & R > 100mm/24h
	Warning R > 150mm/24h

Figure 19: Output (Prospective Warning Criteria [Heavy Rain])

Revised advisory/warning criteria for strong wind have been set.

(1) Approach 1: Statistical analysis using both the disaster records and AWS wind speed data. (Using disaster events whose locations are within 10km from the nearest AWS)

Data used for the analysis:

- AWS wind speed data (hourly, average/gust wind speed) at selected twenty (20) stations co-located at the SYNOP stations.
- Disaster events recorded by the DMC (death toll, destroyed and damaged houses due to strong wind): 703 events.
- Period in scope of the analysis:
  January 2009 to December 2014

Method:

- Extract disaster events whose locations are within 10km from the AWS: 703 → 144 events.
- Extract maximum average/gust wind speed data observed by the AWS 48 hours prior to

the occurrence of each disaster.

- Sort the above extracted AWS wind speed data (144 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind advisory.
- Assume 95th percentile of the wind speed data as possible criteria for strong wind warning.

Results of the Analysis:

Criteria for Advisory: Average Wind Speed > 20km/h, Gust Wind Speed > 45km/h

Criteria for Warning: Average Wind Speed > 40km/h, Gust Wind Speed > 70km/h

(2) Approach 2: Statistical analysis using both the disaster records and AWS wind speed data. (Without considering the distance between the place where the disaster occurred and the nearest AWS)

Data used for the analysis:

- Sort the above extracted AWS wind speed data (144 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind advisory.

Period in scope of the analysis:

- January 2009 to December 2014

Method:

- Use all the disaster events on record even if the distance from the nearest AWS exceeds 10km: 703 events.
- Extract maximum average/gust wind speed observed by the AWS 48 hours prior to the occurrence of each disaster.
- Sort the above extracted AWS wind speed data (703 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind advisory.

Assume 95th percentile of the wind speed data as possible criteria for strong wind warning.

Results of the Analysis:

Criteria for Advisory: Average Wind Speed > 15km/h, Gust Wind Speed > 40km/h

Criteria for Warning: Average Wind Speed > 35km/h, Gust Wind Speed > 75km/h

(3) Approach 3: Statistical analysis using AWS wind speed data. (In consequence of discussion with DOM, sort all the hourly wind speed data in descending order for each AWS station. Assume the averaged 99th/95th percentiles of the wind speed data as possible criteria for strong wind warning/advisory.)

Data used for the analysis:

- AWS wind speed data (hourly, average/gust wind speed) at selected twenty (20) stations co-located at the SYNOP stations.

Period in scope of the analysis:

- January 2009 to December 2014

Method:

- Sort all the AWS wind speed data during the period in scope of the analysis in descending order for each AWS station. (24-hr x 365-day x 6-year data)
- Extract 95th percentile of the wind speed data for each AWS station.
- Extract 99th percentile of the wind speed data for each AWS station.

  * In case AWS wind speed data is missing (-999) or below 1m/s, those data are not included in the statistical analysis.
- Assume the nationwide average of the 95th percentiles as possible criteria for strong wind advisory.

  Assume the nationwide average of the 99th percentiles as possible criteria for strong wind warning.

Results of the Analysis:

Criteria for Advisory: Average Wind Speed > 20km/h, Gust Wind Speed > 35km/h

Criteria for Warning: Average Wind Speed > 25km/h, Gust Wind Speed > 45km/h

Prospective Warning Criteria (Strong Wind)

	Existing Criteria	Approach No.1 Criteria (Disaster Event Analysis)	Approach No.2 Criteria (Disaster Event Analysis)	Approach No.3 Criteria (Statistical Analysis)
Average Wind Speed	Advisory W > 30km/h (Beaufort Scale: 5)	Advisory W > 20km/h (Beaufort Scale: 4)	Advisory R > 15km/h (Beaufort Scale: 3)	Advisory W > 20km/h (Beaufort Scale: 4)
	Warning W > 50km/h (Beaufort Scale: 6)	Warning W > 40km/h (Beaufort Scale: 6)	Warning R > 35km/h (Beaufort Scale: 5)	Warning W > 25km/h (Beaufort Scale: 4)
Gusting Wind Speed	Advisory W > 60km/h (Beaufort Scale: 7)	Advisory W > 45km/h (Beaufort Scale: 6)	Advisory R > 40km/h (Beaufort Scale: 6)	Advisory W > 35km/h (Beaufort Scale: 5)
	Warning W > 70km/h (Beaufort Scale: 8)	Warning W > 70km/h (Beaufort Scale: 8)	Warning R > 75km/h (Beaufort Scale: 9)	Warning W > 45km/h (Beaufort Scale: 6)

Figure 20: Output (Prospective Warning Criteria [Strong Wind])

New advisory criteria for lightning have been set.

(1) Approach 1: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (Assume the averaged CAPE and SSI data as possible criteria for lightning advisory at Dry Zone, Wet + Intermediate Zone and entire country.)

Indicators used:

CAPE and SSI*

*SSI: Showalter stability index

$SSI = T_{500} - T_L$

T_{500}: the temperature (°C) at 500 hPa

T_L: the temperature (°C) of a parcel lifted from 850 to 500 mb, dry-adiabatically to saturation and moist-adiabatically above that.

*By using the correspondence table (TL_table.xlsx) about temperature (T850) and humidity (RH850) at 850hPa and TL at 500hPa, adequateness of SSI was also confirmed.

(References)

Rough indication of atmospheric instability	CAPE	SSI
Stable	< 0	> 0
Weak instability (Chance of thunderstorm)	0 ~ 1000	0 ~ -3
Moderate instability (Chance of severe thunderstorm)	1000 ~ 2500	-3 ~ -6
Strong instability (Chance of severe thunderstorm)	2500 ~ 3500	-6 ~ -9
Extreme instability (Chance of severe thunderstorm)	> 3500	< -9

Source: Japan Meteorological Agency

Data used for the analysis:

- CAPE extracted from the GFS* (lifted from the ground)
- SSI derived from the GFS* (calculated by using T850, T500 and RH850)

*GFS: 0.5 degree grid, 6 hourly initial value, Re-analyzed data
(https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-forcast-system-gfs)

- Lightning observation data from the ROB at the selected twenty (20) SYNOP stations

Period in Scope of the Analysis:

January 2015 to December 2016

Method:

- Select the nearest GFS GPV grids to represent each selected SYNOP station.
- Extract CAPEs and calculate SSIs from the GFS GPV at the time of lightning observation or at the closest time before lightning observation for each SYNOP station.
- Calculate the average of the above extracted CAPEs and calculated SSIs for each SYNOP station.
- Classify the SYNOP stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Assume the area-averaged CAPE and SSI for the two climate zones and whole country as possible criteria for lightning advisory.

Results of the Analysis:

Criteria for Dry Zone:	CAPE > 1300, SSI < -0.8
Criteria for Wet + Intermediate Zone:	CAPE > 1000, SSI < -1.0
Criteria for Whole Country:	CAPE > 1200, SSI < -0.9

(2) Approach 2: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (In consequence of discussion with DOM, sort all CAPE and SSI data in descending order for each SYNOP station. Assume the averaged 99th percentiles of the CAPE and SSI data as possible criteria for lightning advisory.

-The reason for using 99th percentile of CAPE and SSI-

If 100th percentile (largest value) is used, lightning advisory might be hardly issued. As the first stage for operating new lightning advisory, 99th percentile (generally representing extreme value) was adopted.

It is necessary for DOM to accumulate lightning events for a few years and to verify most suitable percentile in the future. (e.g. 95th percentile would be better than 99th.)

Indicators used:

CAPE and SSI

- Data used for the analysis:
- CAPE extracted from the GFS (lifted from the ground)
- SSI derived from the GFS (calculated by using T850, T500 and RH850 extracted from the GFS)

Period in Scope of the Analysis:

January 2015 to December 2016

Method:

- Select the nearest GFS GPV grids to represent each selected SYNOP station.
- Sort all the 6 hourly CAPEs and SSIs in descending order for each SYNOP station.
- Extract the 99th percentile of the CAPE and SSI for each SYNOP station.

* In case CAPE or SSI data are missing (-9999) in the GFS GPV, those data are not

included in the statistical analysis.

- Assume the area-averaged CAPE and SSI for the two climate zones and whole country as possible criteria for lightning advisory.

Results of the Analysis:

Criteria for Dry Zone:	CAPE > 2500, SSI < -3.5
Criteria for Wet + Intermediate Zone:	CAPE > 2000, SSI < -3.5
Criteria for Whole Country:	CAPE > 2300, SSI < -3.5

Prospective Advisory Criteria (Lightning)

Climatic Zone	Approach No.1 Criteria (Lightning Event Analysis)	Approach No.2 Criteria (Statistical Analysis)
Wet Zone + Intermediate Zone	Advisory CAPE > 1000 & SSI < -1.0	Advisory CAPE > 2000 & SSI < -3.5
Dry Zone	Advisory CAPE > 1300 & SSI < -0.8	Advisory CAPE > 2500 & SSI < -3.5
Whole Country	Advisory CAPE > 1200 & SSI < -0.9	Advisory CAPE > 2300 & SSI < -3.5

Figure 21: Output (Prospective Warning Criteria [Lightning])

Internal operation of revised warning criteria of heavy rain and strong wind have been conducted in the period of rainy season (1st inter-monsoon season, 2017).

Procedure of verification :

Every 3 hourly rainfall data observed at the synoptic stations have been used for verifying Heavy Rainfall Warning/Advisory. Every hourly wind data observed at Colombo station have been used for verifying Strong Wind Warning/Advisory.

Criteria of Heavy Rainfall and Strong Wind Warning/Advisory have been verified when Severe Weather Warning/Advisory was issued.

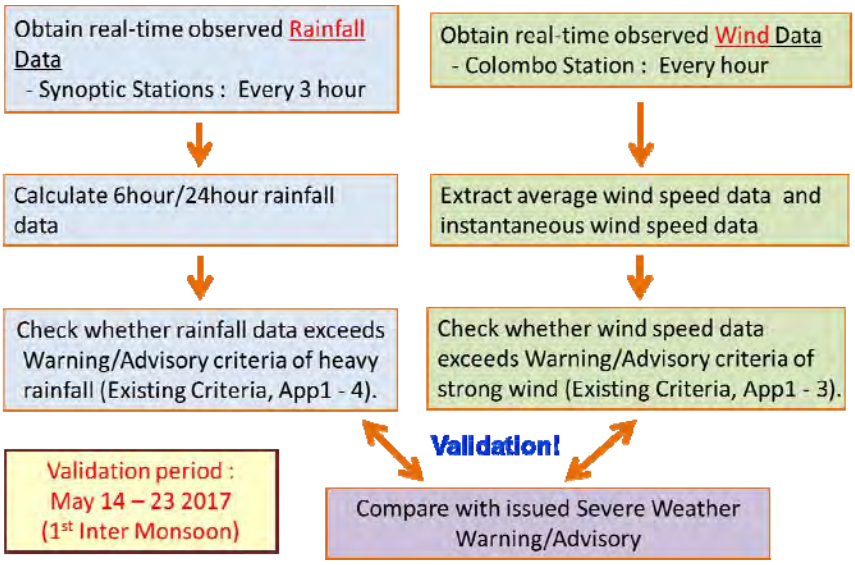
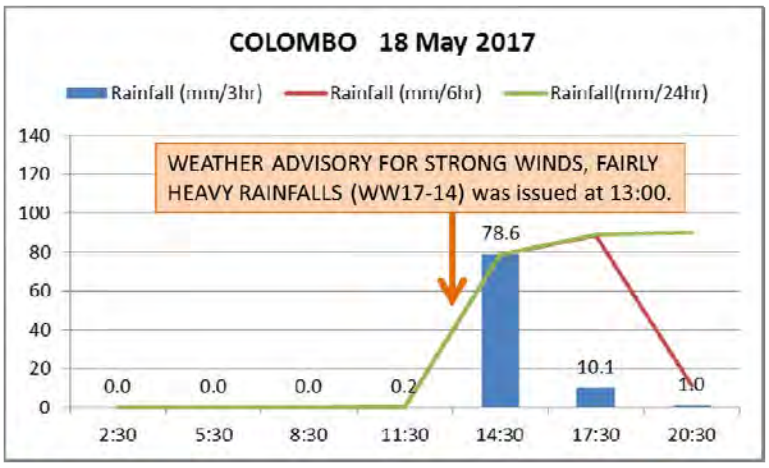


Figure 22: Flow Chart of Validation

Validation result for prospective W/A criteria of heavy rainfall :

Weather advisory for heavy rainfall was issued at 18th May, 2017 13:00.

→Criteria of approaches 3 and 4 satisfied the conditions for issuing advisory at 14:30.



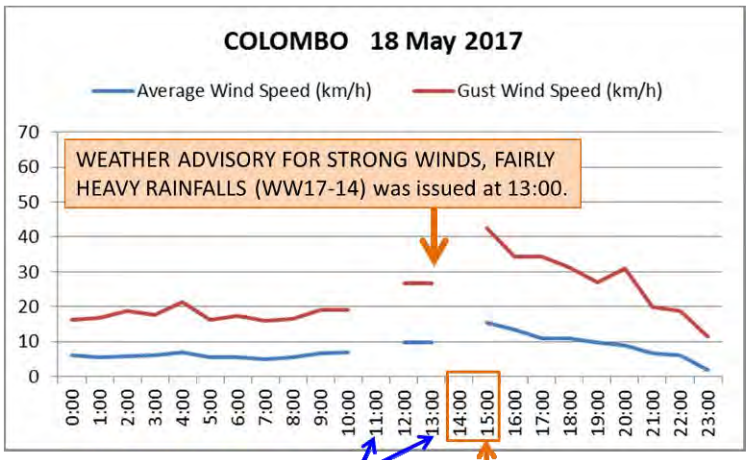
Kind of Criteria	Existing Criteria	Approach No.1	Approach No.2	Approach No.3	Approach No.4
Advisory	—	—	—	14:30 exceeded	14:30 exceeded
Warning	—	—	—	17:30 exceeded	—

Figure 23: Validation Result for Prospective W/A Criteria of Heavy Rainfall

Validation result for prospective W/A criteria of strong wind :

Weather advisory for strong wind was issued at 18th May, 2017 13:00.

→Criteria of approach 2 satisfied the conditions for issuing advisory at 15:00.



Heavy rains accompanied with gusty winds flooded many streets in Colombo yesterday afternoon with heavy traffic reported from many areas in the city as trees uprooted onto roads.Heavy traffic was also reported from Colombo fort,Pettah and Maradana areas after trees fell on roads.A tree fell on Lotus road near the Telecom head office which created traffic jams in the Colombo city.

http://dailynews.lk/2017/05/19/local/116384/torrential-rain-wind-uproot-trees-cause-traffic-main-roads

Kind of Criteria	Existing Criteria	Approach No.1	Approach No.2	Approach No.3
Advisory	—	—	15:00 exceeded	—
Warning	—	—	—	—

Figure 24: Validation Result for Prospective W/A Criteria of Strong Wind

The advisory/warning signs (Heavy Rain, Lightning, Strong Wind, Cyclone & Tsunami) have been improved in compliance with the universal design and which are comprehensible for anyone.

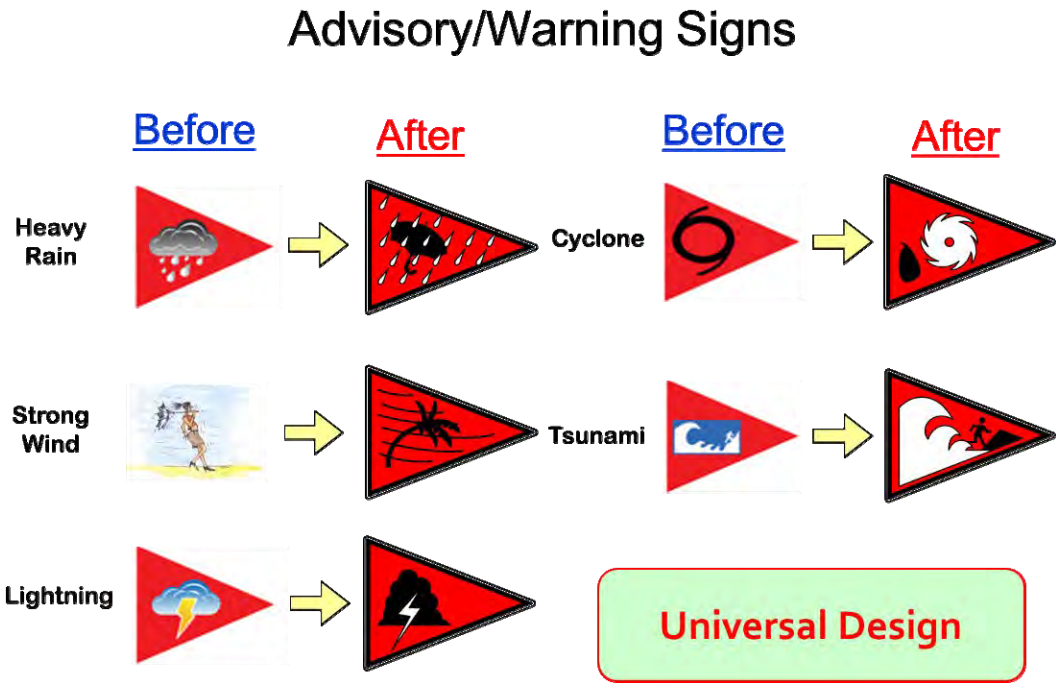
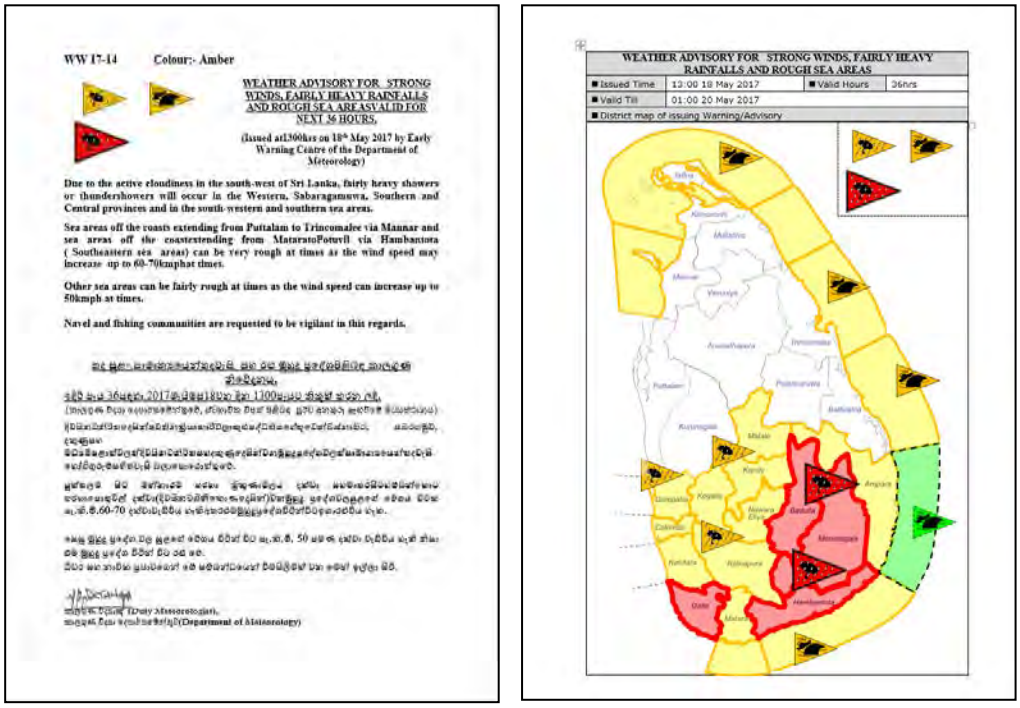


Figure 25: Output (Advisory/Warning Signs)

The advisory/warning bulletins have been improved from TEXT product to VISUAL product. Map information of advisory/warning issued area has been added in the 2nd page.


WW 17-14 Colour:- Amber

WEATHER ADVISORY FOR STRONG WINDS, FAIRLY HEAVY RAINFALLS AND ROUGH SEA AREAS VALID FOR NEXT 36 HOURS.

(Issued at1300hrs on 18th May 2017 by Early Warning Centre of the Department of Meteorology)

Due to the active cloudiness in the south-west of Sri Lanka, fairly heavy showers or thundershowers will occur in the Western, Sabaragamuwa, Southern and Central provinces and in the south-western and southern sea areas.

Sea areas off the coasts extending from Puttalam to Trincomalee via Mannar and sea areas off the coastextending from MataratoPotuvil via Hambantota (Southeastern sea areas) can be very rough at times as the wind speed may increase up to 60-70kmphat times.

Other sea areas can be fairly rough at times as the wind speed can increase up to 50kmph at times.

Navel and fishing communities are requested to be vigilant in this regards.

Daily Meteorologist,
Department of Meteorology

WEATHER ADVISORY FOR STRONG WINDS, FAIRLY HEAVY RAINFALLS AND ROUGH SEA AREAS

Issued Time	12:00 18 May 2017	Valid Hours	36hrs
Valid Till	01:00 20 May 2017		

District map of issuing Warning/Advisory

Figure 26: Improved Advisory/Warning Bulletin

<Monitoring of Operation utilizing new advisory/warning criteria>

Operation utilizing new advisory/warning criteria for heavy rainfall and strong wind and new advisory criteria for lightning has been monitored and lessons learned for feedback to next activities are shown as below.

- New advisory/warning criteria for heavy rainfall and strong wind are now operated by the DOM and these criteria will be verified and revised by them after accumulating weather observation data and disaster events for about 5 years.
- Regarding lightning advisory, 99th percentile value (generally representing extreme value) for CAPE and SSI was adopted as the first stage for operating new lightning advisory. It is necessary for the DOM to accumulate lightning events for a few years and to verify most suitable percentile in the future. (e.g. 95th percentile would be better than 99th.)
- The information of disaster events recorded by the DMC is not described in detail (e.g. location and occurrence time), therefore it is necessary for the DOM to advise the DMC that it should be recorded accurately and precisely.
- New weather radar is under construction in Sri Lanka. If precise precipitation data is obtained after operating new radar, the current advisory criteria of lightning would be improved with more guaranteed accuracy.
- Conducting the same activity in other regions, it is necessary to obtain long-term weather observation data and detail disaster information. Moreover, it is desirable to improve warning sign and bulletin for easy understanding for the public.

<Trainings for "Output 4"＞

Records of the trainings on the Output 4 are summarized in the following table.

Table 44: Training: Warning Elaboration

Date	Time	Venue	Attendee(s)	Conductor	Contents
January 27, 2015	11:00-11:45	Conference Room	6	T. Fujii Y. Uchida	■ Current Situation of Warning Criteria
January 29, 2015	11:00-11:40	Conference Room	8	T. Fujii Y. Uchida	■ Introduction of JMA Advisory and Warning
January 29, 2015	13:30-14:00	Forecasting Centre	1	T. Fujii	■ Current Situation of Warning Criteria

February 5, 2015	13:00-13:30	Conference Room	18	T. Fujii	■ Collection of weather observation data and major disaster events
July 2, 2015	09:30-10:30	Conference Room	6	T. Fujii Y. Uchida	■ Elaboration of heavy rainfall warning ■ Suggestion of new warning sign
July 10, 2015	09:45-10:45	Conference Room	6	T. Fujii Y. Uchida	■ Verification of strong wind warning ■ Suggestion of new warning bulletin
June 29, 2016	09:00-10:00	Forecasting Centre	10	T. Fujii Y. Uchida	■ Discussion about heavy rainfall warning/advisory criteria ■ Verification of strong wind warning/advisory ■ Consideration of lightning advisory ■ Discussion about new warning sign
July 7, 2016	08:45-09:30	Forecasting Centre	7	T. Fujii	■ Discussion about heavy rainfall warning/advisory criteria ■ Introduction of lightning advisory and lightning forecast in Japan
July 11, 2016	13:35-14:05	Forecasting Centre	7	T. Fujii	■ Discussion about heavy rainfall warning/advisory criteria
March 27, 2017	13:30-14:30	Forecasting Centre	5	T. Fujii Y. Uchida	■ Discussion about heavy rainfall warning/advisory criteria ■ Discussion about strong wind warning/advisory criteria ■ Discussion about lightning advisory criteria
May 25, 2017	14:00-15:00	Forecasting Centre	5	T. Fujii S. Iwata	■ Internal operation and validation for prospective warning/advisory criteria

					■ Improvement of the warning bulletin ■ Future challenges after the project

<Remarks on "Output 4">

As a summary of the Output 4, the following table shows the items the DOM is able to implement under the Project and the items the DOM should solve/improve after completion of the Project.

Table 45: Remarks on "Output 4"

Output 4: Warning criteria is elaborated.
Items the DOM is able to implement under the Project
■ To set advisory/warning criteria of heavy rainfall for each climatic/geographical zone. ■ To set advisory/warning criteria of strong wind by using observed wind data and the past wind disaster events recorded by the DMC. ■ To set advisory criteria of lightning by using CAPE and SSI. ■ To verify the newly developed advisory/warning criteria of heavy rain and strong wind using weather observation data and disaster events data recorded by the DMC. ■ To issue the newly visualized advisory/warning bulletin using the newly developed advisory/warning signs in compliance with universal design.
Items the DOM should solve/improve after completion of the Project.
■ New advisory/warning criteria for heavy rainfall and strong wind are now operated by the DOM. On the other hand, advisory/warning criteria should be revised periodically. Therefore, these criteria will be verified and revised by them after accumulating weather observation data and disaster events for about 5 years. ■ Regarding lightning advisory, 99th percentile value (generally representing extreme value) for CAPE and SSI was adopted as the first stage for operating new lightning advisory. Because advisory criteria have been set with 2-year data, it is necessary for the DOM to accumulate lightning events for a few years and to verify most suitable percentile in the future. (e.g. 95th percentile would be better than 99th.) ■ The information of disaster events recorded by the DMC is not described in detail (e.g. location and occurrence time), therefore it is necessary for the DOM to advise the DMC that it should be recorded accurately and precisely. ■ Advisory criteria for lightning have been set with lightning observed data (There are no detail information of location) at the synoptic stations. Therefore, if precise precipitation data is obtained after operating new radar in Sri Lanka, the current advisory criteria of lightning would be improved with more guaranteed accuracy. ■ Conducting the same activity in other regions, it is necessary to obtain long-term weather observation data and detail disaster information for setting advisory/warning criteria with guaranteed accuracy. Moreover, it is desirable to improve warning sign and bulletin for easy understanding for the public.

- Output 5: The method of dissemination and contents of meteorological information are improved.

Activities described in the PDM are as below.

5.1 Review the contents of current meteorological information and identify the issues to be improved.
5.2 Improve the contents of meteorological information.
5.3 Review the timing of information dissemination to ships and fleet.
5.4 Improve the contents of website.
5.5 Prepare smartphone compatible website.
5.6 Prepare educational materials (disaster awareness materials) for the weather services.

Actual activities for Output 5 are described below.

<Identification of the Contents of Meteorological Information and the Current Issues>

- Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified.
  - Most of the weather information was written in text form lacking visual representation.
  - Weather information visualized by graph etc. was small.
  - The existing DOM website was displayed with mixed English, Sinhala, and Tamil languages.
  - The existing DOM website was incompatible with various internet terminals (PC, smart phone, tablet, etc.).
  - Templates could not be changed on the existing DOM website.
  - There was no information on weather educational materials.
- Baseline Survey Report was prepared and submitted to the JICA and the DOM.

<Review the timing of information dissemination>

- Discussions on timing of issuance of meteorological Information for ships and fleet were held.
- After the discussions with the DOM, it was decided to post meteorological Information for

ships and fleet on the new DOM website.

- Meteorological Information for ships and fleet for timely provision to the users was posted on the new DOM website.

<Development of a new DOM website compatible with various Internet Terminals>

In order to overcome the issues clarified in the Baseline Survey, a new DOM website that can be compatible with various Internet terminals (PC, smart phone, tablet etc.) and which can be easily updated, and which satisfies each item listed below was developed under the Project.

- Reduction of character information
- Warning alert placed on top page
- Click button to important information displayed on top page
- Provision of visualized information with graphs etc.
- Display in English, Sinhala, Tamil
- Easy weather information upload
- Posting commentary on simple weather by image
- Posting weather satellite images
- Enabling the publication of meteorological radar images at the time the meteorological radar observation network is completed
- Posting information for educational materials (disaster awareness materials)

In addition, the basic policies of designing a new DOM website are as follows.

- As the design goal of a new DOM website, Keep It Simple (KIS) was adopted.
- Setting up a reasonable blank space (white space) between lines, letters, elements, etc., and made it a website that reduces the burden of reading by the user was considered.
- A website that effectively utilized visual communication (layout (format, composition, grid), typography (type selection, character handling), color and texture, animation etc.) was made.
- As soon as a user sees the page, he/she makes it a structure and design that can understand the contents and functions of the page.

- A clear link to move to another page was made.
- Images were easier to see than text, making bold more prominent than plain text.

The specific activities for the development of the new DOM website are described below

- Brainstorming was conducted to consider the best way to develop a new DOM website.
- Preparation of a new template for the DOM new DOM website was completed.
- After discussions with the DOM, the page layout and design of the new DOM website was confirmed.
- Consultation with the Information and Communication Technology Agency of Sri Lanka (ICT), which operates and maintains all the Websites of the government organizations of Sri Lanka, Joomla 3.4 which is the most suitable CMS (Content Management System) was adopted for realizing compatibility with various Internet terminals (PC, smart phone, tablet, etc.) and easy update.
- In order to develop a new DOM website that adopted Joomla 3.4, the selected local contractor was ordered.
- The DOM applied for updating of a new DOM Website to ICTA.
- The ICTA reviewed the technical regulations and updated the existing website of the new DOM website.
- Confirmation of that the new template has appropriate compatibility was made by a smartphone.
- Improvement/optimization for the Contents created by the DOM on the new DOM website to be appropriately displayed on various internet terminals (Windows, Mac OS, iPhone, iPad, Android, etc.) was carried out.
- An external site "Save Yourself" that can display and download animated cartoons on various Internet terminals was established.
- A link banner was placed on the front page of the new DOM website to access the animated cartoon site named "Save Yourself".
- Japanese meteorological satellite (Himawari 8) was posted on the new DOM website and a meteorological radar image was located on the new DOM website.

The images of the top page of the existing and new DOM websites are attached below.

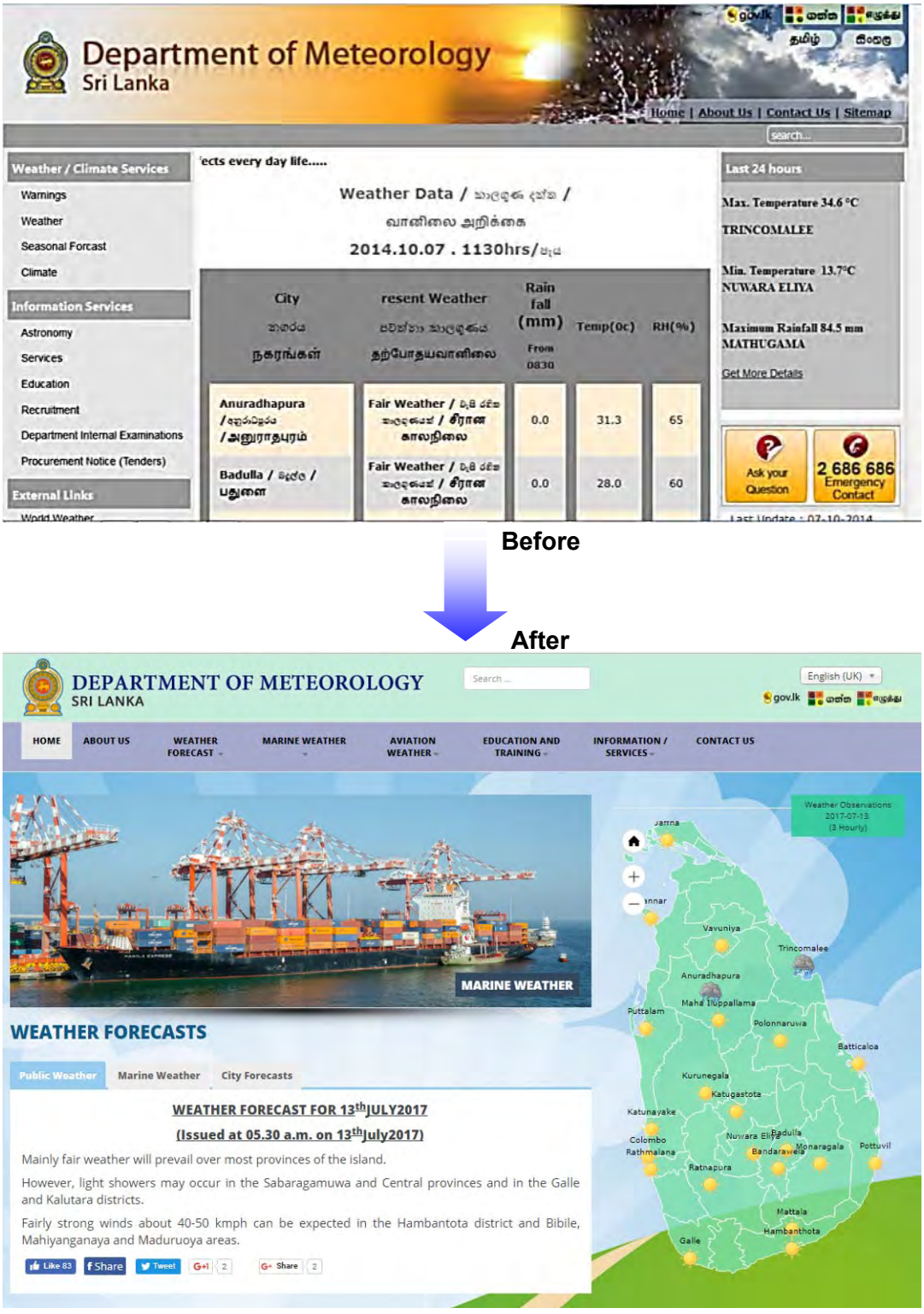


Figure 27: Existing and New DOM Websites

According to the submission of an application by the DOM for updating a new website to the ICTA (Information and Communication Technology Agency of Sri Lanka), the technical review by the ICTA was carried out.

Since the renewal was approved through technical review by the ICTA, the existing DOM website was replaced with a new website on November 25, 2016.

The operation test and adjustment were conducted between November 25 and December 31, 2016, and January 01, 2017 was set as the date of launch of the new DOM website.

The results of the investigation on the number of accesses of the new DOM website are as follows.

- ✧ Average Number of Accesses per day during Baseline Survey: 2,000
- ✧ Target of Average Daily Access of the new DOM website (Indicator of PDM Output: 30% up): 2,600
- ✧ Average Daily Access of the new DOM website between January and July 2017: 2,692 （34.6% up）

As a result, the Indicator of PDM Output which is "access number increased by 30% or more" was satisfied.

Table 46: Number of Accesses of New DOM Website

Month		Total Monthly Access		Days		Average number of Accesses/day
January 2017	:	63,355	/	31	=	2,044
February 2017	:	49,379	/	28	=	1,764
March 2017	:	53,052	/	31	=	1,711
April 2017	:	47,386	/	30	=	1,580
May 2017	:	193,882	/	31	=	6,254
June 2017	:	88,156	/	30	=	2,939
July 2017	:	75,398	/	31	=	2,432
Total	:	570,608	/	212	=	2,692

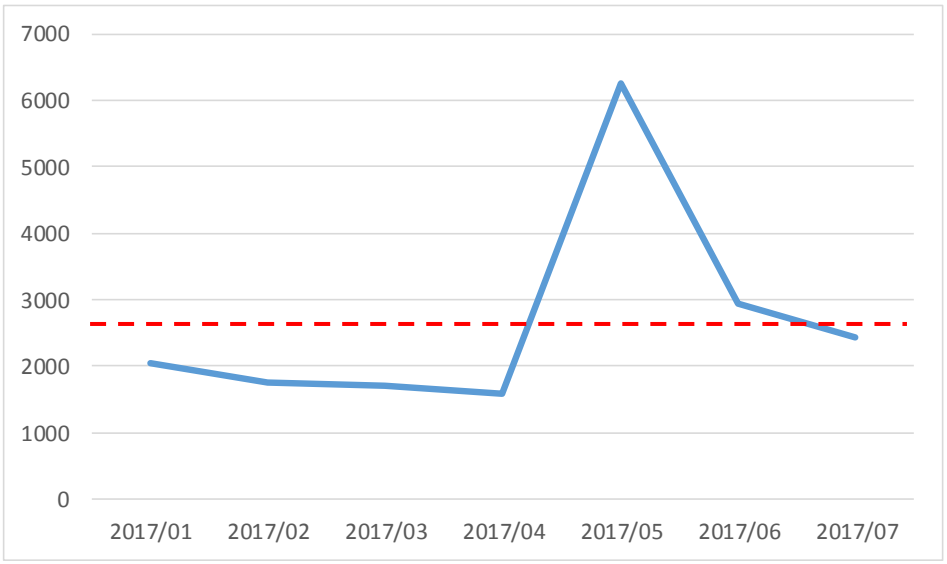


Figure 28: Status of the Number of new DOM

<Educational materials for weather information dissemination: Animated cartoon for awareness program on disaster risk reduction and DOM mascot>

Production of 3 episodes of disaster awareness cartoons (EP1: Climate of Sri Lanka, EP2: Thunderstorm and Lightning and EP3: Heavy Rain and Disaster) in English, Sinhala and Tamil have been completed (voice of 5 characters in the cartoons by DOM personnel) was completed in accordance the Flow of Animation Production attached right side.

Flow of Animation Production

Writing story plot
↓
Character design
↓
Writing script
↓
Production of storyboard
↓
Production of animation
↓
Voice audition
↓
Voice recording
↓
Background music & sound effect
↓
Final output

Figure 29: Storyboard of Disaster Awareness Cartoons

Voice providers for the five animation characters in each language, English, Sinhalese or Tamil, were selected from among DOM staff through a voice audition and voice recording was implemented.

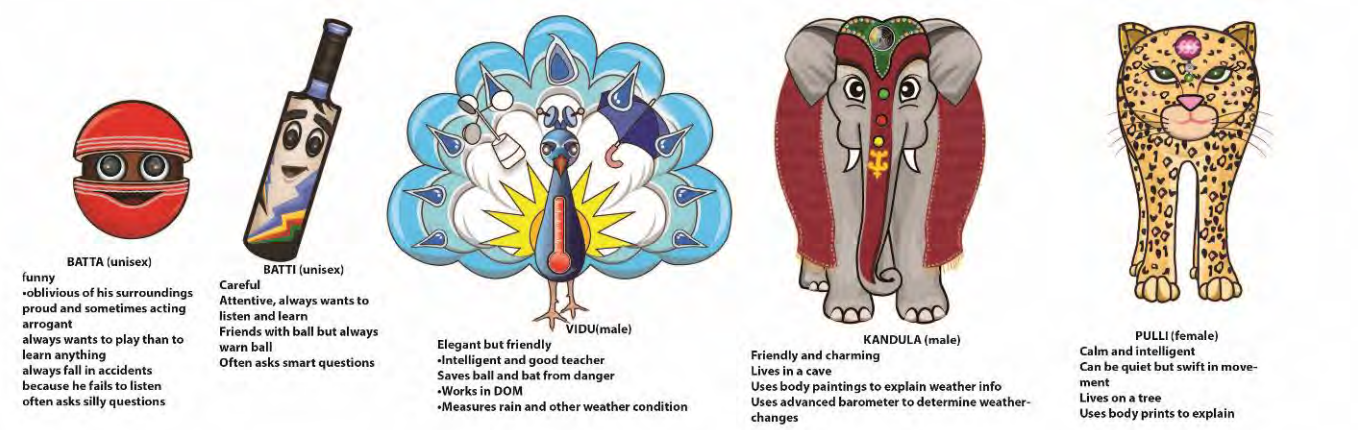


Figure 31: 5 Characters of Disaster Awareness Animation

Production of the DOM mascot for the students who joined the Open Class made of rubber which is cadmium and formaldehyde free material was completed.

<A link banner for accessing the animated cartoon site named "Save Yourself">

A link banner was placed on the front page of the new DOM Website to access the animated cartoon site named "Save Yourself"

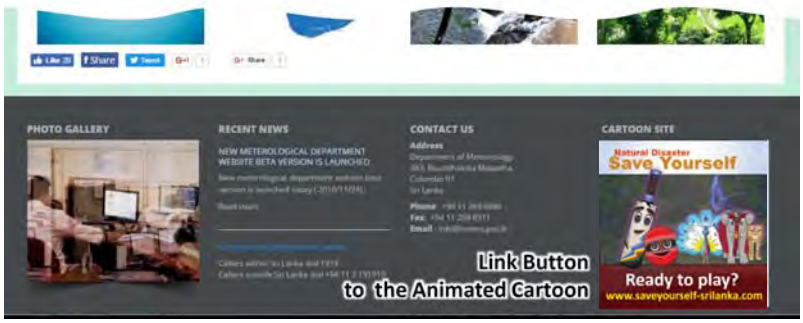


Figure 32: A Link Banner to Access the Animated Cartoon Site

<Open Class>

Open classes using animated cartoon consisting of the three episodes for awareness program on disaster risk reduction were implemented fourteen (14) times in Colombo, Kalutara and Nuwara Eliya districts. Comprehension tests were conducted for 2,922 students/participants just before/after showing the animated cartoon for awareness program on disaster risk reduction to understand their understanding. Implementation of open classes was confirmed to be effective, considering that average score of comprehension test just before/after showing the animated cartoon is fifty two (52) and eighty (80) respectively.

Table 47: Records of Open Class

No.	Date & Time	Venue	Name of School	Shown Version of the Cartoon	Number of Sessions	Grade	Number of Students/ Participants	Average Score	
								Pre Test	Post Test
1	March 08, 2017 14:00-15:00	DOM Auditorium	Siridhamma College, Galle	Sinhala	1	8	209	52	81
2	March 10, 2017 10:00-11:00	Ananda Girl's College, Colombo	Ananda Girl's College, Colombo	Sinhala	1	8	217	60	92
3	March 30, 2017 09:00-10:30	National Youth Corps, Walapana, Nuwara Eliya	National Youth Corps, Walapana, Nuwara Eliya	Sinhala	1	A-D	123	55	91
4	March 30, 2017 11:30-13:00	Nandarama College, Nuwara Eliya	Nandarama College, Nuwara Eliya	Sinhala	1	6-11	121	47	74
5	March 31, 2017 09:00-10:30	T.B.M. Herath Secondary College, Nuwara Eliya	T.B.M. Herath Secondary College, Nuwara Eliya	Sinhala	1	6-11	306	46	77
6	March 31, 2017 12:00-13:30	Kalagamwatta Navodya School, C.S, Nuwara Eliya	Kalagamwatta Navodya School, C.S, Nuwara Eliya	Sinhala	1	6-12	246	43	68
7	March 31, 2017	Community Centre,	(For general public)	Sinhala	1	—	75	—	—

	15:30-17:30	Kandayaya, Nuwara Eliya.							
8	April 26, 2017 10:00-11:30	Princess of Wales girls school. Colombo	Princess of Wales girls school. Colombo	Sinhala	1	8-9	440	62	89
9	May 19, 2017 10:45-12:10	Walagedara Navoya School, Mathugama, Kalutara	Walagedara Navoya School, Mathugama, Kalutara	Sinhala	1	9-11	258	68	93
10	May 23, 2017 09:40-11:10	Holy Trinity Central College, Nuwara Eliya	Holy Trinity Central College, Nuwara Eliya	Tamil	1	8-13	487	51	80
11	May 23, 2017 15:25-16:35	Maskeliya Plantation P.L.C. Troup Estate Dispensary & Maternity Ward, Talawakelle, Nuwara Eliya	"Barathy Maha Vithyalayan, Talawakelle, Nuwara Eliya	Tamil	1	6, 8-13	51	47	71
12	2 May 23, 2017 17:15-18:00	Talawakelle Tea Estate P.L.C. Holyrood Estate Training Centre	(For tea plantation workers and their children)"	Tamil	1	—	64	—	—
13	May 24, 2017 09:20-11:00	St. Xiver's College, Nuwara Eliya	(For tea plantation workers)	Tamil	1	6-13	255	37	60
14	May 24, 2017 11:20-12:20	St. Xiver's College, Nuwara Eliya	St. Xiver's College, Nuwara Eliya	Sinhala	1	1-11	70	—	—
			Total				2,922	52	80

<Educational materials for weather information dissemination: Beaufort Wind Scale>

Laminated sheets of Beaufort Wind Scale on Land and at Sea in three languages, English, Sinhalese and Tamil, were made. The laminated sheets of Beaufort Wind Scale were distributed to visitors to the DOM such as school teachers, government officials, military personnel in charge of meteorological services, staff of overseas weather-related organizations and others.

<Cloud Types for Observers in Sri Lanka>

According to the WMO regulations, cloud types are to be reported instead of individual cloud shapes in exchanging meteorological data. So far, DOM observers have referenced cloud photos taken mainly in mid-latitude by WMO or NOAA. For this reason, the Consultant Team had attempted to make and complete the DOM original "Cloud Types for Observers" in which the required 27 cloud photos are all taken in Sri Lanka. Unfortunately, the 4 of the 27 pictures indicated in red frames on the right figure could not be taken in Sri Lanka within the Project period. Therefore alternative 4 pictures taken in other countries are temporarily used. This is to request the DOM to take the remaining 4 types of the cloud pictures and replace the current pictures with them for the completion of the DOM original "Cloud Types for Observers"

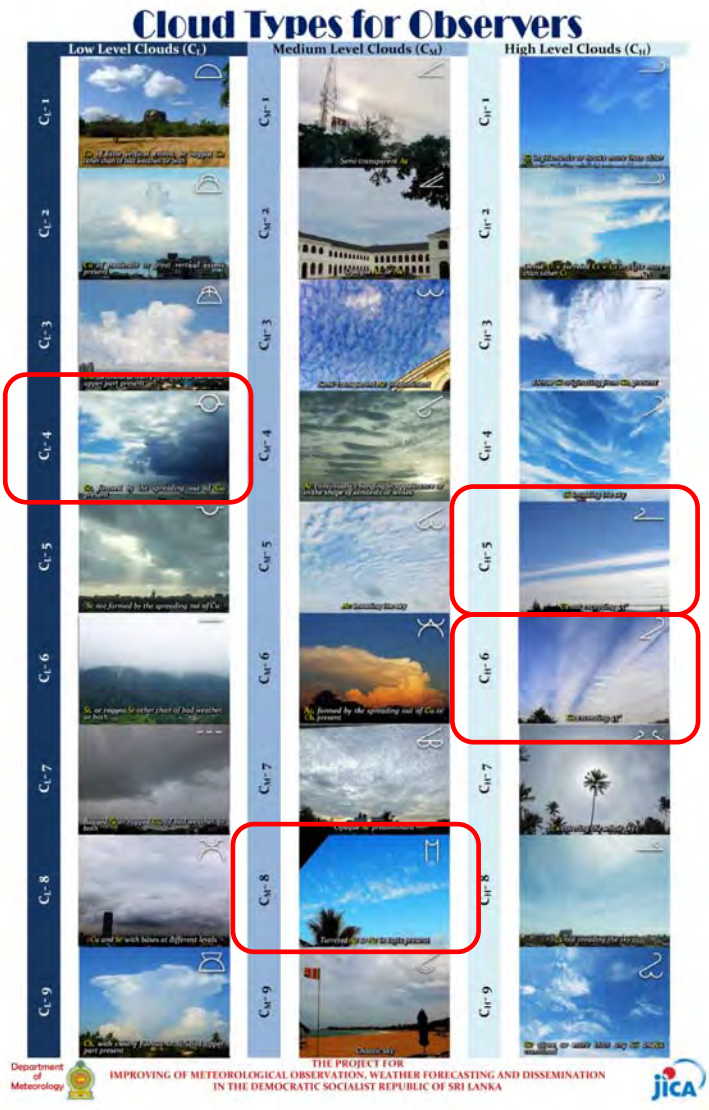


Figure 33: Cloud Types for Observers in Sri Lanka

<Trainings for "Output 5">

Record of the trainings on the Output 5 are summarized in the following table.

Table 48: Training: Weather Information Dissemination

Date	Time	Venue	Attendee(s)	Conductor	Contents
April 7, 2015	10:30-11:00	Project Office	2	S. Iwata R. Zaman	■ Planning of Animation Development
April 7, 2015	11:00-12:00	Data Processing and Archival Division Room	1	S. Negoro	■ Understanding current work process of Joomla
April 8, 2015	15:45-16:15	Project Office	1	S. Iwata R. Zaman	■ Preparation of Site Visit for Understanding Flood and Landslide Prone Area
April 9, 2015	08:30-18:30	Colombo~Kalutara	1	S. Iwata R. Zaman S. Negoro	■ Site Visit for Understanding Flood and Landslide Situation (Kalutara District)
April 10, 2015	13:00-13:50	Data Processing and Archival Division Room	1	S. Negoro S. Iwata R. Zaman	■ Discussion about the Design of Web Improvement
April 10, 2015	14:00-15:15	Conference Room	5	S. Iwata R. Zaman	■ Animation Development (Story Plot, Characters, etc.)
April 15, 2015	14:10-14:40	Mr.Premalal's Room	1	S. Iwata R. Zaman S. Negoro	■ Animation Development (Story Plot, DOM Mascot, etc.)
April 15, 2015	15:30-16:00	Mr.Premalal's Room	1	S. Iwata S. Negoro	■ Understanding the Climate of Sri Lanka
April 17, 2015	8:30-9:00	Project Office	2	S. Iwata R. Zaman S. Negoro	■ Understanding the Climate of Sri Lanka
April 21, 2015	10:30-12:00	Data Processing and Archival Division Room	7	S. Negoro S. Iwata	■ Brainstorming of Website.
June 22, 2015	13:00-14:00	Data Processing	1	S. Negoro	■ Information exchange of

		and Archival Division Room			the current progress of contents by using Joomla!
June 24, 2015	11:00-16:00	Data Processing and Archival Division Room	1	S. Negoro Y. Uchida	■ Information exchange of Joomla! Operation
June 26, 2015	09:30-10:00	Mr.Mahesh's Room	1	S. Iwata	■ Preparation of Visit to Tank Systems in Polonnaruwa District for Understanding Climate of Dry Zone
June 30, 2015	15:00-15:30	Data Processing and Archival Division Room	1	S. Negoro	■ Provision of Access Information for the Web Template (Draft) by Mobile Phone
July 2-3, 2015	-	Colombo~ Polonnaruwa	1	S. Iwata	■ Discussion on Technical Information to be Used in the Animation ■ Visit to Tank Systems in Polonnaruwa District for Understanding Climate of Dry Zone ■ Visit to the DOM Regional Office for Understanding Disasters in Polonnaruwa District
July 6, 2015	14:30-15:30	Data Processing and Archival Division Room	2	S. Negoro	■ Configuration of the Shared Server
July 9, 2015	10:00-11:00	Conference Room	12	S. Negoro Y. Uchida	■ Discussion on the Website (Draft Template)and Contents Layout for the New Website
July 9, 2015	11:00-11:15	Conference Room	12	S. Iwata Y. Uchida	■ Discussion on the DOM Mascot and the Other Four Characters to be Used in the Animation

July 6-10, 2015	30 min each	Project Office, Forecasting Centre	1	S. Iwata	■ Discussion on Technical Information to be Used in the Animation
July 6-10, 2015	15 min each	Mr.Premalal's Room , Forecasting Centre	1	S. Iwata Y. Uchida	■ Discussion on the DOM Mascot ■
December 3, 2015	11:00-11:15	Project Office	1	S. Iwata	■ Meeting on Work Plan of the Animation Development in This Month
December 9, 2015	10:00-10:15	National Meteorological Center	1	S. Iwata	■ Meeting on DOM's Warning Color to be Used in EP3 of the Animation
December 14, 2015	14:30-15:00	National Meteorological Center	3	S. Iwata Y. Uchida	■ Meeting on Selection of Five (5) Characters' Names of the Animation
December 15, 2015	16:30-17:00	National Meteorological Center	1	S. Iwata Y. Uchida	■ Meeting on Final Selection of Five (5) Characters' Names of the Animation ■ Meeting on Three (3) Storyboards for EP1 to EP3 of the Animation
December 16, 2015	14:00-14:30 15:00-15:30	Training and Aviation Division & Rainfall Division	3	S. Iwata	■ Meeting on Three (3) Storyboards for EP1 to EP3 of the Animation
December 17, 2015	10:30-11:00	Training and Aviation Division & Rainfall Division	2	S. Iwata	■ Meeting on Three (3) Storyboards for EP1 to EP3 of the Animation
December 17, 2015	16:00-16:30	Project Office	1	S. Iwata	■ Meeting on Three (3) Storyboards for EP1 to EP3 of the Animation
June 10, 2016	09:50-16:40	DOM Studio	4	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)

June 13, 2016	09:40-16:00	DOM Studio	3	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 14, 2016	09:45-15:50	DOM Studio	2	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 14, 2016	11:00-12:00	National Meteorological Center (NMC)	3	Y. Uchida M. Yamauchi	■ Discussion on the Website Contents and Layout
June 16, 2016	09:45-12:30	DOM Studio	2	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 17, 2016	09:40-15:10	DOM Studio	3	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 17, 2016	10:30-12:00	National Meteorological Center (NMC)	9	Y. Uchida M. Yamauchi	■ Discussion on the Website Contents and Layout
June 20, 2016	10:00-16:00	DOM Studio	3	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 21, 2016	10:05-16:10	DOM Studio	2	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 22, 2016	10:10-14:25	DOM Studio	2	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3,

					English/Sinhala/Tamil)
June 23, 2016	09:30-12:00	DOM Studio	1	S. Iwata R. Zaman	■ Acting and Voice Recording for the Animated Cartoon (EP1 to EP3, English/Sinhala/Tamil)
June 28, 2016	14:00-16:00	Conference Room	12	S. Iwata	■ Drawing Graphics by PowerPoint
June 29, 2016	10:00-11:30	National Meteorological Center (NMC)	20	Y. Uchida M. Yamauchi	■ Operation Training of New DOM Website
June 29, 2016	10:30-11:30	National Meteorological Center (NMC)	3	M. Yamauchi	■ Operation Training of New DOM Website
June 30, 2016	14:00-15:30	Forecasting Centre	7	S. Iwata	■ Drawing Graphics by PowerPoint
March 29, 2017	10:00-13:00	Computer Division	6	Y. Uchida T. Endo	■ Operation Training of New DOM Website
May 30, 2017	15:00-16:00	Forecasting Centre	6	S. Iwata	■ Drawing Graphics by PowerPoint

<Remarks on "Output 5">

As a summary of the Output 5, the following table shows the items the DOM is able to implement under the Project and the items the DOM should solve/improve after completion of the Project.

Table 49: Remarks on "Output 5"

Output 5: The method of dissemination and contents of meteorological information are improved.
Items the DOM is able to implement under the Project
■ To become possible to promote the website preparation work by themselves due to understanding the procedures and points, etc. to consider when preparing new websites ■ To update daily forecasts, weather information, etc., and add, delete and correct of displayed contents, on the DOM website created using Joomla 3.4, the latest version of the content management system. ■ To conduct Open Classes using the animated cartoon on disaster risk reduction. ■ To expand implementation places for Open Class other than schools, such as training center for tea plantation workers, local clinic, etc. ■ To secure staff within DOM who can provide their voice for animated cartoons as awareness material

and can give appropriate instructions to the voice providers. ■ To draw simple graphics by using drawing functions of PowerPoint.
Items the DOM should solve/improve after completion of the Project
■ To collect and analyze the opinions of website users and continue to improve the website as necessary ■ To negotiate with ICTA and realize the remote access to DOM website for modification/updating in consideration of responding more quickly. At present, it is impossible to modify/update the DOM website from places other than the computer section of the DOM head office. ■ To negotiate with ICTA and improve the response speed to access to the DOM website. ■ To regularly conduct Open Classes at the DOM auditorium using the animated cartoons on disaster risk reduction. ■ To conduct Open Classes at places having poor accessibility of educational services. ■ To secure enough annual budget to conduct Open Classes. ■ To take the remaining 4 types of cloud pictures and replace the current pictures with them for the completion of the DOM original “Cloud Types for Observers”

4. Records of the Trainings conducted in Sri Lanka under the Project

The records of the trainings conducted in Sri Lanka under the Project are indicated in the following table. The detailed records of the trainings are available in the foregoing.

Table 50: Records of the Trainings conducted in Sri Lanka under the Project

PDM Outputs	Number of Training	Total Number of Attendees	Total Training Hours
1. Capacity on maintenance and calibration of meteorological observation equipment is improved	20	110	61H30M
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	5	30	13H00M
3. Capacity of weather forecasting is improved using obtained meteorological data.	22	116	35H15M
4. Warning criteria is elaborated.	11	79	09H50M
5. The method of dissemination and contents of meteorological information are improved.	44	155	88H35M
Total	102	490	208H10M

5. Issues, Ideas and Lessons Learned During Project Implementation

The challenges encountered during project implementation along with the efforts taken by the DOM and ourselves to solve the challenges and the lessons learned arising from such challenges and efforts towards the achievement of the Overall Goal of the Project are indicated in the table attached hereunder. The additional challenges to note and the recommendations for implementation of a similar project are also described. In addition, we express our appreciation to the DOM for their positive and constructive cooperation during the project implementation.

Table 51: Challenges, Efforts and the Lessons Learned from the Implementation of the Project

Topics	Action Undertaken
Flexible Countermeasures during Project Implementation	Flexible countermeasures created through close cooperation under the harmonious relationship between the DOM and the Consultant Team was a proactive response to the inaugurations of a new President and major government officials according to the results of the presidential and general elections in 2015. This is in addition to the unfortunate long leave taken by the Director General of the DOM due to medical reasons during the Project Implementation.
Sustainability of the Project Activity	The project activities and its outputs are expected to be continued or utilized after the Project. Therefore, the Consultant Team tried to support its DOM counterparts to conduct the activity through their own initiative instead of the Consultant Team conducting the activity by themselves. The outputs of the Project will include official plans, guidelines, and systems in order to sustain the activity.
Allocation of the Required Budget	In a technical cooperation project, a recipient country is supposed to bear the funds necessary for the project and its smooth implementation. It is necessary to prepare the budgetary request which is submitted to the Ministry of Finance and Planning (MOFP) of Sri Lanka for each year of the Project period by the end of August of every year (the fiscal year is January 1 to December 31). Since the amount of budget required for the next year was clarified by the DOM and the Consultant Team together according to the submission period of the annual budget and the DOM has timely made the budgetary request to secure the necessary budget, fortunately, there is no significant problem in this regard. Through the Project, it is considered that the DOM counterparts understood well what JICA's technical cooperation project is.
Challenges and Recommendations for the Implementation of Similar Project	One of the best ways to formulate a new project is that the Japanese side understands the needs of the counterparts and proposes the recommended activities, and the counterparts make the request for a similar project officially based on the recommendation. In the case of this project, the needs of a recipient country were understood and the contents of the activities, which could be supported by Japan, were discussed by taking a long time for the preparatory survey. This will be the ideal example of the project formulation.

Issues, ideas and lessons learned of each Output of the PDM during Project Implementation are listed in the following table.

Consultant Team

JICA Long Term Expert

Table 52: Issues, Ideas and Lessons Learned During Project Implementation

Output of the PDM	Issues during Project Implementation	Recommended Solutions to the Issues Raised for the DOM
1. Capacity on the maintenance and calibration of meteorological observation equipment is improved.	1. At the beginning of the Project, JICA had a policy to partly reduce the procurement of the required equipment as indicated in the Record of Discussions (ROD) due to a lack in project budget. Nevertheless, the DOM requested JICA to procure all the required equipment as outlined in the Record of Discussions (ROD) for the smooth implementation of the Project.	1. After due reconsideration, JICA has decided to allocate the budget necessary for the procurement of all the required equipment in the Record of Discussions (ROD) and has procured all of them during Phases 1 and 2 of the Project. The guideline for the surface meteorological observations and maintenance manuals of meteorological instruments had been prepared by the consultant experts, and the guideline and manuals for instrument calibration by the long-term expert.
	2. The DOM has not systematically prepared regulations, guidelines and manuals for the maintenance, inspection and calibration of the meteorological observation instruments.	2. As a result of the consultation with the Long Term Expert, the DOM has prepared the necessary regulations, guidelines and manuals for the maintenance, inspection and calibration of the meteorological observation instruments.
	3. The DOM has been conducting a series of maintenance and inspection work using the original manuals and inspection record books provided by the manufacturer. Since the DOM has introduced measures against lightning strikes and bird damages, such manuals and record books need to be revised. However, as the manufacturer did not provide an electronic copy, it had been difficult to reflect and	3. The DOM revised the existing manuals and record books, matching the present situation and rewrote them using MS Word in doc format. The revision points made in the manuals and record books were reported in the annual "Officers-in-Charge Meeting" wherein the representative of each weather observation station participate in.

	document these measures.	
	4. The DOM did not have a Barometer Calibration Device needed to ensure the traceability of the barometer. The Thermometer Inspection Bath of the DOM did not have enough facilities so a zero point test was not conducted.	4. The DOM established the traceability of its meteorological instruments in regard to pressure and temperature since the additional procurement of the Barometer Calibration Device, Thermometer Inspection Bath and Ice Shaving Machine was done during Phase 2 of the Project.
	5. The DOM did not have an instrument calibration laboratory and the calibration was made in of the office of the instrument division of DOM	In order to sustainable establish of the traceability of meteorological instruments, a new instrument calibration laboratory was designed, and was constructed by the expenses and personnel of the DOM and JICA.
	6. Concerning the review of the upper-air observation schedule in DOM: the current situation of the radiosonde observation and the pilot-balloon observations in DOM were examined, and daily observation of radiosonde was recommended to DOM by the long-term expert.	After the recommendation by the long-term recommendation to the DOM, daily radiosonde observation has not been still started. It also found that the safety handling in filling a balloon with hydrogen gas was not enough. A short-term expert of upper-air observation was invited from JMA and implemented the second investigation of the upper-air observation of the DOM and conducted the training on upper-air observation for DOM staff. Through these investigations and training, the final report concerning the improvement of upper-air observation in the DOM was produced and provided to the DOM.

2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	1. After the specialist consultant conducted a practical trial for changing the data communication method of the AWS from VSAT to IP-VPN, the DOM took about 1.5 years to contract an IP-VPN communication company. Throughout this period, the operation of AWS was stopped.	1. We requested the DOM several times to conclude a contract for the provision of an IP-VPN as soon as possible and to resume the operation of the AWS. (The DOM completed the contract for an IP-VPN in May 2017 and restarted the operation of AWS in June 2017.)
	2. It took much more time than the DOM expected to finish the customs procedure of the equipment on the occasion of updating the GTS/MSS. As a result, the schedules of equipment installation and trainings were delayed.	2. We did an adjustment of the equipment installation and training within our schedule. As the DOM requested practical training of receiving aviation weather data, we conducted additional practical training.
	3. The DOM requested the India Meteorological Department for the delivery of Binary Meteorological Data on the occasion of updating GTS/MSS but it has not yet been delivered.	3. The DOM was able to receive the Binary Meteorological Data after getting in contact with a staff from the India Meteorological Department who was in charge of the GTS based on the information of the Japan Meteorological Agency.
3. Capacity of weather forecasting is improved using obtained meteorological data.	1. Since weather forecasts in the National Meteorological Centre are implemented by 4 teams (a team is composed of 1 Forecaster, 3 Observation Officers, 3 Communication Officers and 1 Forecasting Assistant) following a 2 shifts/day schedule, some of the forecasting personnel who are not on duty were unable to attend trainings conducted on their day-off.	1. In case that some of the forecasting personnel attend trainings during their holidays, they are considered as working days (overtime). In addition, we have conducted trainings as per their requests for forecasting personnel who are not on duty to prevent technical level gaps.
4. Warning criteria is elaborated.	1. With regard to the improvement of strong wind warning/advisory, disaster information (location and time) of strong wind recorded by the DMC were only rough estimates (only date information) and the existing wind observation network is still not enough to estimate real wind speed at the point	In order to conduct a more accurate analysis of weather warning, it is essential to document disaster events continuously and record detailed information such as the date of occurrence and location. On the other hand, the weather observation network (rainfall, wind and lightning) is

	of strong wind disaster. Therefore, it was difficult to analyze the relationship between strong wind disaster and maximum wind speed.	desirable to be denser spatially. With regard to lightning advisory, besides the NWP product, observed data from SATAID such as top cloud temperature data also seems to be available for issuing advisory.
	2. As for the newly established lightning advisory, the criteria were settled based on the NWP (GFS model) value whose resolution is slightly sparse (50km grid) to describe real atmospheric state. When operating lightning advisory, we must take into consideration the computation error of the NWP.	
5. The method of dissemination and contents of meteorological information are improved.	1. There is a large difference in the length of the recorded voice in English, Sinhala and Tamil even for the exact same dialogue while the mouth movement of the animation character is exactly the same for the three languages. Therefore, we faced the difficulty to adjust the speaking time to be same among the three languages.	1. Under the supervision of rare DOM staff who are trilingual in English, Sinhala and Tamil, we modified the scripts in order to squeeze or extend speaking time without compromising the key message and gave appropriate instructions to the voice providers selected from the DOM.
	2. The DOM started to operate the improved Website. The technical staff of the Information and Communication Technology Agency of Sri Lanka (ICTA, administrator of the operation of the website of all government organization including the DOM) do not troubleshoot issues during night-time. The staff cannot input aviation weather information such as METAR, etc. into the DOM Website from the Aviation Meteorological Office.	2. We requested the DOM to ask the ICTA for night-time troubleshooting so that the DOM can issue a warning (heavy rain, tsunami etc.) during night-time without any failure. We requested the DOM to provide a PC for the data input station in the Aviation Meteorological Office.

6. Project Achievement

The Progress of the Project Achievements at the end of the Project is indicated in the following table.

Consultant Team

JICA Long/Short Term Expert

Table 53: Project Achievement

Project Purpose	Indicators	Achievements of Project Purpose
Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Traceability of meteorology instruments (Availability of national standards/frequency of inspection)	As originally planned, through the procurement of standard instruments and calibration devices and the implementations of training courses, the traceability of pressure and temperature has been established during the project. Through the productions of "Guideline to meteorological instrument calibration" and "Manuals for meteorological instrument calibration", the procedures of the calibration of pressure and temperature have been well defined and standardized. DOM has been starting the operation of the new instrument calibration.
	2. Number of missing observation data	The missing rate of real−time observation data transfer from 36 observation stations (one place not installed and the other one is Colombo) was 100% since the VSAT communication satellite that the DOM was using stopped the service from January 2016. After completion of the transition from VSAT to IP-VPN system, it is foreseen that the missing rate of real−time observation data transfer will be less than 10%.
	3. Accuracy of rainfall forecast in the selected stations.	Preparations for the increase in the accuracy of rainfall forecast have been completed after the completion of rainfall forecast guidance 12, 24 and 36 hours ahead at 2 points (Colombo and Ratnapura) using the Grid Point Value of DOM's numerical prediction model (WRF). Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the WRF Grid Point

		Vale has been operating for the increase in the accuracy of rainfall forecast of Colombo.
	4. Number of selected station where weekly forecast is enabled in trial basis.	Colombo and Ratnapura: Weekly forecasts guidance was conducted from January to July 2017 on a trial basis using Model Output Statistics (MOS) with the GFS numerical prediction model of the NOAA.
Output	**Indicators**	**Achievement of Output**
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	1-1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project.	Revision of the following manuals for Automatic Weather Observation System have been completed. 1) Cleaning/Inspection Procedure including Cleaning/Inspection Report 2) Preventive Maintenance Record 3) Basic Trouble Shooting and Inspection Procedure 4) Spare Parts (Sensor) Replacement Procedure for Recovery
	1-2 Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff.	29 engineers, technical officer (81% of the total relevant DOM staff) and meteorological officer have participated in the training sessions.
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	2-1 Data from AWS are obtained and made available to a full extent in DOM.	The missing rate of real−time observation data transfer from 36 observation stations (one place not installed and the other one is Colombo) was 100% since the VSAT communication satellite that the DOM was using stopped the service from January 2016. After completion of the transition from VSAT to IP-VPN system, it is foreseen that the missing rate of real−time observation data transfer will be less than 10%.
	2-2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project.	Binary data from the India Meteorological Department have been obtained.
3. Capacity of weather forecasting is improved using obtained meteorological	3-1 At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance.	15 Forecasters can produce the short range and weekly weather forecast guidance.
	3-2 At least 4 persons in DOM	15 Forecasters can produce the weather forecast guidance of sea wind.

data.	obtain ability to produce the weather forecast guidance of sea wind.	
4. Warning criteria is elaborated.	4-1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared.	■ Warning/advisory criteria of heavy rain: 2 climatic zones (Wet Zone and Intermediate Zone / Dry Zone) and 2 geographical zones (Plain Area / Mountain Area) ■ Warning/advisory criteria of strong wind: 1 area (whole country) ■ Advisory criteria of lightning: 2 climatic zones (Wet Zone and Intermediate Zone / Dry Zone)
5. The method of dissemination and contents of meteorological information are improved.	5-1 Number of developed educational material for weather services.	■ DOM mascot for disaster awareness ■ Disaster Awareness Cartoons for Disaster Prevention Education 1) Climate of Sri Lanka (English, Sinhala and Tamil) 2) Thunderstorm and Lightning (English, Sinhala and Tamil) 3) Heavy Rain and Disaster (English, Sinhala and Tamil) ■ DOM Beaufort Scale 1) Land (English, Sinhala and Tamil) 2) Sea (English, Sinhala and Tamil) Total: 6 materials
	5-2 Monthly access number of the DOM Website is increased by 30% or more.	The number of DOM website accesses per day have increased by 34.6%. (Comparison of the beginning of the project and average values from January to July 2017)

7. Recommendations towards the Achievement of the Overall Goal

<Recommendation from the Consultant Team>

The Overall Goal of the Project is for the "weather information disseminated from the DOM is well utilized by the public and the disaster related organizations". For that purpose, it is important to issue highly accurate weather forecasts and warnings to contribute to mitigating the damage caused by natural disasters, and as a result, it is necessary to improve the public trust with the DOM's weather information.

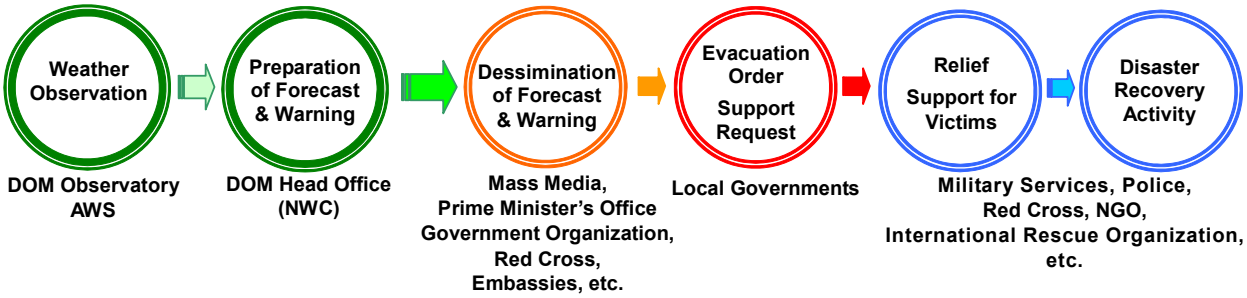


Figure 34: Issuance of Meteorological Forecasts & Warnings and Collaboration with Disaster Prevention related Organizations to be Strengthened

In order to alleviate damage from gusts, floods and landslides caused by heavy rain in Sri Lanka, it is important that the DOM grasps accurately the current weather conditions through observation and issues highly accurate weather forecasts and warnings. Furthermore, it is indispensable for each disaster prevention related organization to cooperate with each other and to fulfill their own services. In particular, the DOM has the role of the preparation of accurate forecasts/warnings and promptly disseminating them to each organization, and the information from the DOM is a trigger for the initial activity of each disaster prevention related organization. For that reason, further improvement of the weather forecasts/warnings of quantitatively (= issuance frequency) and qualitatively (= accuracy) is strongly required in order to further strengthen the DOM's meteorological observation system, reliably send observation data to the National Weather Center (NWC) in the DOM Head Office, analyze and process the information and reflect these observation data in the forecasts.

In order to further enhance the benefits of the Project, recommendations towards the achievement of the Overall Goal of the Project are as follows.

1) Manpower Development

- The development of more qualified technical personnel through continuous training and other related manpower development programs; and,
- The conduct of timely research to increase the level of understanding/knowledge about meteorological disasters.

2) Natural Disaster Prevention and Management

- The creation of effective communication and collaboration with the various government agencies, NGOs, and international institutions for better coordination of natural disaster prevention and management;
- The formulation of effective and consistent disaster prevention schemes through different stages from Weather Forecasting, Warning Announcement, Disaster Occurrence, Information Dissemination, all the way to Evacuation Stage;
- Implement and ensure wider dissemination of knowledge and information on disaster-prevention activities to all sectors including government disaster management agencies, the private sector, and the population at risk;
- Setting up of redundancies in the announcement of warnings and other information dissemination to ensure reaching out to the general populace;
- Continuing education to the general public, especially the population at risk, through the Local Government Units (LGUs) in coordination with various related disaster management agencies on effective natural disaster prevention and management;
- Further strengthening of a cooperative structure among the mass media (TV, radio, newspaper), the Prime Minister's Office, Ministry of Disaster Management, Ministry of Irrigation & Water Resources Management, Ministry of Transport, Ministry of Agriculture, Civil Aviation Authority, Ministry of Health & Indigenous Medicine, Ministry of Fisheries and Aquatic Resource Development, Ministry of Highways, Ports & Shipping, Department of Police, Fire Station, other government-affiliated organizations, Sri Lanka Red Crescent Society, etc.; and,
- Furtherance of utilization of the meteorological information/data and forecasts/warnings by the mass media (TV, radio, newspaper), the Prime Minister's Office, Ministry of Disaster Management, Ministry of Irrigation & Water Resources Management, Ministry of Transport, Ministry of Agriculture, Civil Aviation Authority, Ministry of Health & Indigenous Medicine, Ministry of Fisheries and Aquatic Resource Development, Ministry of Highways, Ports & Shipping, Department of Police, Fire Station, other government-affiliated organizations, Sri Lanka Red Crescent Society, etc.

<Recommendation from the Long-term Expert>

1) Modernization of surface meteorology observation

- The current parallel operation of the conventional manual observation and the automatic observation at the DOM regional offices have been a large burden regarding budget and human resources.
- Transformation to automatic observation using the current AWS network should be planned.
- Firstly, several test bed stations making automatic observation should be started to make the total plan of the transformation.
- Training for the observers on full automatic observation using the AWS should be implemented in parallel.
- After establishing the technology of automatic observation, the full automatic observation except visual observations will be started at the all sites.

2) Renovation of the organization of DOM

- In accordance with the modernization of the surface meteorological observation and installation of the dual-polarization Doppler radar systems, the renovation of the organization of the DOM and re-education/relocation of human resources should be planned.
- It should be discussed that the role of the regional offices of the DOM will be shifted from the traditional observation sites to the disseminating bases of weather information for the local citizen.

3) Capacity development

- DOM has been making efforts to do capacity development through the inhouse training, the JICA group training and graduate programs in foreign countries. Such capacity developments should be continued taking account individual abilities of the DOM staff members. The Japan government should particularly support graduate programs in Japan.

- Research activities and inhouse seminars concerning meteorological analysis on weather disaster events should be made in order to enhance their knowledge on the latest meteorology.

4) Establishment of the system of rules

- Acts covering the entire weather services of the DOM, rules, guidelines and manuals for all the missions of the DOM should be prepared in order to provide for and standardize the weather services of the DOM.

8. Recommendations for further contribution for mitigating the damage caused by natural disasters by the DOM

Since more than 90% of the major disasters in Sri Lanka were caused by hazardous meteorological phenomena, meteorology has indeed become a matter of life or death in Sri Lanka. As such, the role of the DOM, the only meteorological organization in the country, is crucial and important. In order for the DOM to mitigate the damages generated by the disasters caused by hazardous meteorological phenomena, it is a priority issue to detect hazardous meteorological phenomena which may create massive damages and disseminate highly accurate forecasts/warnings to the public more appropriately and promptly before the risk of disasters further escalate.

Recommendations of each Output of PDM for further contribution for mitigating the damage caused by natural disasters by the DOM are described in the following table.

Table 54: Recommendations towards the Achievement of the Overall Goal

Output of PDM	Recommendations
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	・ To continue the new instrument calibration scheme established in the project and ensure the traceability of the meteorological instruments concerning pressure and temperature through the constant calibration of the domestic meteorological instrument. ・ To continue intimate communication and collaborative relationship with the overseas Regional Instrument Center of the WMO, particularly with RIC-Tsukuba ・ Concerning instruments of humidity, wind and rainfall, to start the establishment of the traceability of instruments, by installing the standard instruments and calibration tools and receiving technical supports from the RIC-Tsukuba. ・ To implement regular calibration of the DOM standard instruments with the RIC standard instruments in order to ensure the traceability of instruments. ・ To install an internet line to the instrument division of the DOM and to contact the RIC-Tsukuba in order to continue to exchange information on the instrument traceability. ・ To schedule daily radiosonde observation considering the budget and human resources of the DOM.

2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	・ To encourage and continue the maintenance of the observation fields (prevention of animal intrusion, etc.) and the environmental improvement of the observation rooms (installing an air conditioner). ・ In order to enhance and guarantee the continuous operation of the automatic weather observation systems (AWS) and to ensure the technical training of the electrical engineering staff, the establishment of appropriate measures against system failure, scheduled replacement of parts and a fully documented maintenance system with proper document control is indispensable. ・ To conduct technical training for new staff and periodic inspection by the manufacturing company for the stable operation of the GTS/Message Switching System (MSS).
3. Capacity of weather forecasting is improved using obtained meteorological data.	・ Continuous recruitment of human resources for roles in forecast operation for the next generation. Simultaneously, the development of excellent weather forecasters need to be sustained by conducting forecast trainings within the DOM, encouraging staff to attend a training program abroad and supporting staff to earn Masters or Doctoral degrees. ・ To conduct accurate evaluation of the Local Numerical Weather Prediction WRF model aimed at actual operation, to put the Weather Guidance using the data of the WRF model/the Global Numerical Weather Prediction Model to practical use. ・ To accumulate the grid point values (GPV) after the calculation of the WRF model every day for the evaluation and the improvement of the model. ・ Continuous improvement of overall forecasting works taking in the knowledge and data of meteorology. ・ In order to understand real time local weather conditions across the country and utilize them for disaster prevention operations, it is imperative to transmit observation data of all the AWSs to the DOM Head Office without any delay for accurate evaluation of the Numerical Weather Prediction and Weather Guidance.

4. Warning criteria is elaborated.	・ To create an updated, accurate and consistent database of meteorological disasters (disaster occurrence time, disaster location, damage situation, weather condition, weather information and transmission condition). ・ To conduct further research to increase the level of understanding/knowledge about meteorological disasters and its mechanisms along with other related meteorological phenomena. ・ To improve forecasting works relevant to meteorological disasters through the implementation of the above recommendations at the same time continually develop human resources capable of doing the verification and review of warning criteria.
5. The method of dissemination and contents of meteorological information are improved.	・ In order to reduce natural disaster risk, it is important to improve the cooperation with organizations/agencies related to disaster management and mass media as the means for transmission of disaster information. ・ To conduct continuous public awareness activities about disaster prevention. ・ In order for the public to find weather information easier, it is necessary to improve the DOM's website continuously. ・ To develop and recruit the human resources needed to implement the above recommendations. ・ To continuously conduct Open Class both in Colombo city and in local regions. ・ To continuously develop human resources within the DOM who can conduct Open Class. ・ To exchange ideas and opinions on a regular basis with stakeholders on the method of dissemination and the contents of meteorological information through the Monsoon Forum conducted biannually by the DOM, and try to feed back the results into the DOM's activity and products for further improvements. ・ To continuously inform availability of the renewed DOM website through the Monsoon Forum and Open Class. ・ To produce "Weather Summary on Severe Weather Disaster (tentative title)" immediately after disaster occurrence (within one day after the disaster), and distribute it to the relevant organizations and be on the DOM website.

9. Comments of the Consultant Team Leader and Long-term Expert on the Strategic Direction of Further Cooperation with the DOM

<Consultant Team Leader>

In order for the weather information provided by the Department of Meteorology in Sri Lanka to contribute to the mitigation of damage caused by meteorological disasters, the provision of accurate and quantitative weather information is required.

Under this project, while preparing the short-term forecast guidance with the predicted values of the WRF Model of the DOM using the grid point values of the GFS published by the NOAA for the initial condition and boundary condition, and corresponding observation data, the training on the weather forecast guidance mechanism, preparation method and accuracy verification method have been conducted. Through these training, the understanding of the DOM on weather forecast guidance has deepened. However, in order to effectively use the forecast result based on the weather forecast guidance in the weather forecast issued by the DOM, it is necessary to further improve the accuracy of the DOM's WRF Model.

The WRF model is a meteorological mesoscale numerical weather forecast model developed mainly by the NOAA and the National Center for Atmospheric Research (NCAR) in 2006. Currently, 3-dimension data assimilation and 4-dimensional data assimilation have been developed. The forecasting range is several thousand kilometers. Not only is the main body of the forecast model released but also pre-processing, data assimilation and post-processing programs are available for free to use. As such, meteorological organizations and research institutes in many countries make use of it. Although the DOM is experimentally conducting WRF operation, however DOM have not achieved accurate forecast results by utilizing the various functions of WRF. This situation is almost similar in other meteorological organization in other developing countries. I recommend to improving accuracy of DOM's WRF Model by acquiring data assimilation function and program update methods, etc.

After the completion of this Technical Cooperation Project, the Project for the Establishment of a Doppler Weather Radar Network under the Japan's Grant Aid has been scheduled to commence from 2018. Further improvement in accuracy can be expected by incorporating the data observed by this weather radar into the WRF model. As a direction of future support, we believe that the implementation of cooperative projects shown in the table below, centering on improving the accuracy of the WRF model, is effective in improving DOM capacity and

reducing damage caused by natural disasters.

Table 55: Expected Technical Cooperation to be required for the DOM

Component	Activity
Improvement of accuracy of WRF Model	Update the latest version of the WRF model ・ Update of WRF Model main program ・ Update of WRF Model preprocessing system ・ Introduction of WRF Model data assimilation system
	Improvement of WRF Model basic configuration ・ Improvement of grid distance (High resolution) ・ Configuration of calculation time corresponding to grid distance ・ Expansion of calculation area
	Improvement of operation method of WRF Model ・ Improvement of initial value Three-dimensional data assimilation of four kinds of data including AWS, Meteorological Radar, Upper Air Observation and Meteorological Satellite Data ・ Improvement of initial conditions and lateral boundary conditions Incorporation of grid point data with small grid distance (high resolution)
	Method of processing calculation results ・ Preparation of Numerical Forecast Map around Sri Lanka using analysis and display system of grid point data (GrADS) ・ Implementation of an automatic operation processing of various weather guidance using results of WRF Model
Radar Data Utilization	Workshop on meteorological radar data (radar animation images) utilization and interpretation/commentary method for the mass media
	Workshop on meteorological radar data (rain intensity and Doppler data) utilization and interpretation for the Civil Aviation
	Explanation of radar products
	Utilization technique of meteorological Doppler radar data for torrential rain monitoring
Graphical Weather Information	Practical training on radar image improvement/modification (setting of rainfall catchment areas, adding symbols on Sri Lankan map indicated on radar images, etc.)
Weather Forecast	Short time (0.5-1 hours) forecast with the radar data of torrential rain and the existing automatic weather observation system data
	Practical training for forecast briefing with meteorological radar data

<Long-Term Expert>

On the way of implementing our project, problems and future issues in the current DOM

meteorological services, which should be solved, have been clarified. During three years of the project period, more than 400 people have been lost by floods and landslides in Sri Lanka. Considering these facts, we can have clear idea on what is the most important and the most needed in the DOM weather services. The largest issues in the current DOM weather services are the drastic improvement of rainfall observation and the real-time dissemination of more accurate rainfall information with higher horizontal resolution. It is required to establish a real-time rainfall monitoring system with the horizontal resolution less than the horizontal size of thunderstorms which induced heavy rainfall.

Fortunately, the weather radar system installed in Sri Lanka in 2020 by JICA are planned to have the state-of-the-art dual-polarization function. The new weather radars will be expected to provide much more accurate rainfall estimation than conventional weather radars have done, and will be capable to issue adequate rainfall information in real-time. Therefore, a next JICA technical cooperation project should be planned concerning operation/maintenance of the radar system and also utilization of radar observation data, in order to make completely new weather information against heavy rainfall disasters.

Meanwhile, we believe that in parallel with the technical improvement of weather services, the DOM should continue to concentrate their effort particularly on strengthening their administrative aspects: the planning of modernization of the meteorological observation, the renovation of the organization of the DOM, the enhancement of capacity development and the establishment of regal rules such as “Meteorological Services Acts”, with cooperation of the Japanese Government.

Since dissemination of accurate rainfall information is the first step for the rainfall disaster management, the DOM should make quality assurance of rainfall data by conducting calibration of rain gauges operated relevant organizations, and should make the guidance to the usage of rainfall data for these organizations and public. The DOM also should make a development plan as a medium-term plan for rainfall disaster prevention products such as Soil water index”, “Runoff index” and “Inundation index” using rainfall data with the technical cooperation from Japan Meteorological Agency. These efforts will lead the DOM to establish initiatives on the rainfall disaster management among the relevant organizations in Sri Lanka.

Finally I would like to extend sincerely thank to the Japan Meteorological Agency for great

support from them through the implementation of the project. Their support has been extending from the preparation survey of the project in January 2014 to the final training course on "SATAID" in August 2017. The activity of the establishment of the traceability of meteorological instruments particularly could not be completed if there were no help from JMA. Nine JMA staff visited Sri Lanka as the short-term experts training courses and gave the DOM staff technical trainings. In the two JICA C/P training programs conducted in Japan, many JMA staff were engaged in the arrangement and implementation of the programs. I again appreciate their spending effort and time devoted to us during their daily busy business in the JMA.

Meanwhile, I have an opinion that there have been some possibility to receive the following supports from the JMA: quality control of meteorological observation data in the Activity 1 of the project, the planning of the exchange of binary data through the new GTS/MSS in the Activity 2, implementation of the training courses on the latest numerical weather prediction and the latest forecast guidance technique in the activity 3, the advice to the subdivision of the regions to where weather warnings are issued in the Activity 4, and introducing the functions of the JMA website to the renovation of the DOM website in Activity 5.

The JMA is currently assigning the international cooperation with meteorological organizations of foreign countries as one of their important policies. Considering this situation, I hope that the JICA will promote the relationship with the JMA and will extend the area of technical cooperation projects with cooperation with JMA, such as administrative cooperation concerning renovation and strengthening of foreign meteorological organizations.

10. Records of the Joint Coordinating Committee and the Seminar

The Joint Coordinating Committees (JCCs) held at the Office of the Ministry of Disaster Management are indicated in the following table.

Table 56: Records of the Joint Coordinating Committee

Date	Participants	Venue	Relevant Items discussed
October 14, 2014	Ministry of Disaster Management: 3 DOM: 3 JICA Sri Lanka Office: 4 JICA Long Term Expert: 1 JICA Short Term Expert (Consultant): 4	Ministry of Disaster Management	・Explanation of the Work Plan of the Project ・Approval of the PDM revised by the Consultant ・Expiation of the Activities to be made in the Phase 1 ・Equipment Procurement under the Project
November 18, 2016	Ministry of Disaster Management: 1 DOM: 2 JICA Sri Lanka Office: 3 JICA Long Term Expert: 1 JICA Short Term Expert (Consultant): 6	Ministry of Disaster Management	・Expiation of the project progress and the activities made by the DOM and the JICA Experts ・Introduction of the project outputs (Animated cartoon “Save Yourself”, Beaufort Scale on Land/at Sea, etc.) ・Introduction of the renewed DOM website ・Issues to be hampered for smooth implementation of the Project
May 02, 2017	Ministry of Disaster Management: 1 DOM: 2 JICA Long Term Expert: 1 JICA Short Term Expert (Consultant): 3	Ministry of Disaster Management	・Report of the current progress of the Project Achievement ・Report of the current progress of the Project Purpose ・Introduction of draft of Recommendations Towards the Achievement of the Overall Goal
July 26, 2017	Ministry of Disaster Management: 1 DOM: 6 JICA Headquarters: 2 JICA Long Term Expert: 1 JICA Short Term Expert (Consultant): 4	Ministry of Disaster Management	・Report of the Project Achievement ・Report of the Project Purpose ・Introduction of Recommendations Towards the Achievement of the Overall Goal

Seminar (Arranged by the Long-term Expert)

The project seminar "Next Generation Weather Services focusing on Rainfall Disaster Mitigation in Sri Lanka" was held on 25 July 2017 (Photo 10-1). This seminar aimed at discussing the optimal scheme of the weather services in Sri Lanka for heavy rainfall disaster in accordance with the disaster risk reduction road map in Sri Lanka which was introduced in the JICA-MDM joint seminar in June 2017, and with the JICA Grant Aid Program "Project for the Establishment of a Doppler Weather Radar Network in Sri Lanka" for 2018-2020. The program of the seminar is described in Table 57.

People from the Ministry of Disaster Management of Sri Lanka (MDM) including the Disaster Management Center (DMC), the National Building Research Organization (NBRO), and the Ministry of Irrigation and other organizations were participated in the seminar. Two short-term experts from the JMA, the long-term experts staying at the MDM and the DOM presented the political and operational schemes for mitigating heavy rainfall disasters in Japan. At the end of the seminar, the JICA international cooperation specialist proposed a future plan of the DOM to intensify its function.


Photo 10-1 Seminar “Next Generation Weather Services focusing on Rainfall Disaster Mitigation in Sri Lanka".

Table 57 Program on the Seminar “Next Generation Weather Services focusing on Rainfall Disaster Mitigation in Sri Lanka".

Time	Session	Speaker/Facilitator
9:00 – 9:20	Participant registration	
9:20 – 9:30	Opening speech	Mr. S. Miyanawala (Secretary, MDM)

9:30 – 9:40	Weather services in disaster risk reduction of Sri Lanka and purpose of the seminar	Mr. Y. Inoue (Acting Director of Disaster Risk Reduction Team 1, JICA)
9:40 – 9:55	Achievement of the Weather Project during this three years and the target of this seminar	Mr. S. Premalal (Director General, DOM)
9:55 – 10:10	Weather services of DOM for heavy rainfall disaster	Ms. Anusha Warnasuriya (DOM)
10:10 – 10:30	Tea break With Video show of the disaster prevention awareness video for children "Save Yourself"	Mr. Y. Uchida and Mr. Iwata (JICA Consultant Expert, DOM)
10:30 – 10:50	Disaster management system in Japan focusing on flooding and landslides	Mr. T. Nagai (JICA Long-term Expert, MDM)
10:50 – 11:10	History of the weather services for heavy rainfall disaster in JMA	Dr. M. Ishihara (JICA Long-term Expert, DOM)
11:10 – 11:40	Necessity of Quantitative Precipitation Estimation (QPE) for monitoring rainfall disaster using dual polarization Doppler radars	Dr. A. Adachi (Meteorological Research Institute, JMA)
11:40 – 12:10	Importance of Quantitative Precipitation Forecast (QPF) using observation networks and numerical models	Mr. K. Nagata (JMA HQs)
12:10 – 12:30	Comments on strengthening the relationship between DOM and relevant organizations to establish the next generation rainfall disaster management in Sri Lanka	Mr. S. Premalal(DOM)
12:30 – 13:00	Road map to the next generation weather services focusing on rainfall disaster mitigation in Sri Lanka	Mr. K. Akatsu (Senior Advisor, JICA HQs)
13:00 – 13:10	Closing remarks	Mr. F. Tanaka (Chief Representative, JICA Sri Lanka Office)
13:10 –	Lunch	

MDM: Ministry of Disaster Management
DOM: Department of meteorology
NBRO: National Building Research Institute
JICA: Japan International Cooperation Agency
JMA: Japan Meteorological Agency

Annexes

FINAL REPORT

ON
THE PROJECT FOR IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Annexes

Table of Contents

Annex 1

Revision of the Project Design Matrix (PDM)

Revision of the Project Design Matrix (PDM)

■1st Revision (October 14, 2014)

The revision of certain items to make the descriptions more concrete were proposed and approved at the Joint Coordinating Committee (JCC) conducted on October 14, 2014 at the Ministry of Disaster Management.

The original PDM and 1st revised PDM (revised parts: blue color) are attached hereunder.

PROJECT DESIGN MATRIX (PDM) [Original]

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1 Traceability of meteorology instruments (Availability of national standards/frequency of inspection) 2 Number of missing observation data 3 Accuracy of rainfall forecast in the selected stations. 4 Number of selected station where weekly forecast is enabled in trial basis.	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes.
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved. 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened. 3. Capacity of weather forecasting is improved using obtained meteorological data. 4. Warning criteria is elaborated.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project. 1.2 Training on inspection and repairing of AWS is conducted for XX% of the relevant DOM staff. 2.1 Data from AWS are obtained and	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	Necessary budgets for maintaining meteorological equipment are allocated to DOM in 2015 and 2016.

5. The method of dissemination and contents of meteorological information are improved.	made available to a full extent in DOM. 2.2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least XX persons in DOM obtain ability to use the weather guidance. 3.2 At least XX persons in DOM obtain ability to forecast short range sea surface wind. 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM Website is increased by XX% or more.	- The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the short range forecast - Training records on the weekly range forecast - Draft warning criteria - Educational material for weather services	
Activities	**Inputs**		**Pre-conditions**
1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments. 1.4 Conduct training on calibration of conventional and AWS equipment. 1.5 Review and revise the Standard Operation Procedure	Japanese side <u>Long-term expert:</u> Chief Adviser / Expert of Weather Services <u>Short-term experts:</u> - Expert of Meteorological Observation	Sri Lanka side <u>Administration:</u> Project Director, Project Manager <u>Counterpart personnel:</u> C/P personnel from the relevant divisions under DOM	The appropriate counterpart personnel to participate in a series of training provided by the Project are secured.

for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule. 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. 2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters. 2.3 Review the current situation on GTS/MSS, and identify the issues to be improved. 2.4 Replace and upgrade the GTS/MSS 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct training on development of weather guidance products for short range (36 hrs.) and weekly weather forecast including their forecast verification techniques. 3.3 Prepare weather guidance products for short range and weekly at the selected stations. 3.4 Conduct training for short range sea surface wind forecast utilizing satellite data. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). 3.6 Review and evaluate the seasonal weather forecasting methods. 3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of	- Expert of Satellite Data Analysis - Expert of Meteorological Observation Technology - Expert of Weather Forecasting / Weather Guidance Method - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant <u>Machinery and Equipment:</u> - Desktop or Laptop Computers - Desktop Computer for WIS - Display for Briefing of Weather Forecasting - Laptop Computer with data reader to download data from AWS logger - Multifunction machine (Printer / Photocopy) - GTS/Message Switching System - Travelling Calibration System (temperature and pressure sensors) - Second Standard Instruments (electric temperature and pressure sensors) - Spare parts for AWSs including	<u>Facilities and Equipment:</u> - Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment <u>Budgetary Arrangement by DOM:</u> Administration and local operation costs	

various data. 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and occurrence of lightning. 5.1 Review the contents of current meteorological information, and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of website of the headquarters. 5.5 Prepare smartphone compatible website. 5.6 Prepare educational material (ex. website, CDs, leaflet and publications) for weather services.			

PROJECT DESIGN MATRIX (PDM) [Revised-1]

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM. 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM.	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1 Traceability of meteorology instruments (Availability of national standards/frequency of inspection) 2 Number of missing observation data 3 Accuracy of rainfall forecast in the selected stations. 4 Number of selected station where weekly forecast is enabled in trial basis.	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes.
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved. 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened. 3. Capacity of weather forecasting is improved using obtained meteorological data. 4. Warning criteria is elaborated.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project. 1.2 Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff. 2.1 Data from AWS are obtained and	- Annual administration reports of DOM - Record of the JCC meetings - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	Necessary budgets for maintaining meteorological equipment are allocated to DOM in 2015 and 2016.

5. The method of dissemination and contents of meteorological information are improved.	made available to a full extent in DOM. 2.2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance. 3.2 At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind. 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM Website is increased by 30% or more.	- The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the weather guidance (up to 36 hours ahead and 168 hours ahead) - Draft warning criteria - Educational material for weather services	
Activities	**Inputs**		**Pre-conditions**
1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments. 1.4 Conduct training on calibration of conventional and AWS equipment. 1.5 Review and revise the Standard Operation Procedure	**(Japanese side)** Long-term expert: Chief Adviser / Expert of Weather Services Short-term experts: - Expert of Meteorological Observation - Expert of Satellite Data Analysis Experts dispatched from the consultant:	**(Sri Lanka side)** Administration: Project Director, Project Manager Counterpart personnel: C/P personnel from the relevant divisions under DOM Facilities and Equipment	The appropriate counterpart personnel to participate in a series of training provided by the Project are secured.

for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule. 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. 2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters. 2.3 Review the current situation on GTS/MSS, and identify the issues to be improved. 2.4 Replace and upgrade the GTS/MSS 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification. 3.3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations. 3.4 Produce weather forecast guidance of sea wind at the selected stations. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). 3.6 Verify and improve the existing methods of seasonal forecast. 3.7 Conduct on-the-job training on improvement of	- Leader / Expert of Weather Forecasting - Expert Weather Guidance - Expert of Meteorological Observation Technology - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant <u>Machinery and Equipment:</u> - Laptop PC for the training of weather guidance method - Laptop PC for downloading data from AWS logger - Display for Weather Briefing - Multifunction machine (Printer / Photocopy) - Printer - Portable Calibration System (Portable AWS)(temperature, atmospheric pressure, humidity, wind direction and wind speed) - Standard Meteorological Instrument (electric temperature and pressure sensor) - Spare parts for AWS - Laminating machine	- Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment <u>Budgetary Arrangement by DOM</u> Administration and local operation costs	

weather forecasting operation through integration of various data. 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning strike. 5.1 Review the contents of current meteorological information and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of website. 5.5 Prepare smartphone compatible website. 5.6 Prepare educational materials (disaster awareness materials) for the weather services.	- Laptop PC for the training of editing a website - Software for editing a website - Additional lightning protection system - Public Address System for Open Class - Projector for Open Class - Spare bulb for Projector - Extension power cable for Open Class- - GTS/Message Switching System (including installation, adjustment, and initial operation instruction)		

Annex 2

Flowchart

Fiscal Year: FY2014 | FY2015 | FY2016 | FY2017

Month: 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8

Phase: Phase1 | Phase2

Japan | Sri Lanka | Japan | Sri Lanka | Japan | Sri Lanka | Japan | Japan | Sri Lanka | Japan | Sri Lanka | Japan | Sri Lanka | Japan

Activities

Capacity on the maintenance and calibration of the meteorological observation equipment is improved.

- To identify the existing issues to be improved upon regarding the maintenance and calibration of the meteorological observation instruments
- To Assist the preparation of specifications for the standard meteorological instrument for calibration and the equipment for the inspection and adjustment
- To review and improve the existing upper air observation schedule (Long-term expert)
- To Procure the standard meteorological instrument which have the traceability
- To organize the maintenance and calibration team(s) in the DOM
- To implement the operation, maintenance and calibration with user's guide(s) and manual at all sites of the automatic weather observation systems by DOM
- To prepare the calibration of the meteorological observation instruments manual
- To conduct trainings on the calibration of the manual observation instruments of synoptic meteorological stations
- Trainings on the calibration of the manual observation instruments
- To review and improve the existing operation & maintenance rules of the observation fields and the meteorological observation instruments
- To conduct trainings on the calibration of the automatic weather observation systems (AWOS)
- To prepare the operation & maintenance manual of the observation fields and the meteorological observation instruments
- To conduct trainings on the inspection and repair of the automatic weather observation systems (AWOS)
- To prepare the meteorological observation rule(s)
- To prepare the meteorological observation manual(s)
- To conduct trainings on the weather observation
- To review the existing user's guide(s)
- To prepare the user's guide(s) of the repair (replacement of spare parts)
- To prepare maintenance and management record book

Transmitting and receiving capacity of various kinds of meteorological data is strengthened

- To identify the existing issues to be improved upon regarding observation data transmission/receipt of the automatic weather observation systems (AWOS).
- To derive an alternative for the observation data transmission/receipt of the automatic weather observation systems (AWOS)
- To discuss on necessary function of GTS Message Switching System
- To identify the existing issues to be improved upon regarding the existing GTS (Global Telecommunication System) Message Switching System
- To Assist the preparation of specifications required for procurement of GTS Message Switching System
- To support procurement of the equipment

Capacity of weather forecasting is improved using obtained meteorological data

- To identify the existing issues to be improved upon regarding the weather forecasting capacity and capability of the DOM
- To procure the required equipment and configure the required software into the procured equipment for the development of weather guidance.
- To conduct trainings on the weather guidance
- To conduct trainings on sea surface wind forecasting with satellite data
- To conduct trainings to improve weather forecasts utilizing various meteorological data and integration.
- To review and improve the existing methods/procedures on seasonal weather forecasting
- To conduct trainings on the operation of the SATAID

Warning criteria is elaborated

- To identify the existing issues to be improved upon regarding the warning criterion of the DOM through proper scrutiny.
- To create a new warning criterion of heavy rain, strong wind and lightning through discussions with the concerned agencies on disaster management.

The method of dissemination and contents of meteorological information are improved

- To identify the existing issues to be improved regarding the dissemination methods of weather information by the DOM
- To improve the contents of the weather information (weather forecast, weather information and marine weather report) released by the DOM
- To improve the means of expression and dissemination methods (web page, mass media) of weather information by the DOM
- To regularly update and maintain the products on the Web page by the DOM
- To create public relations materials on meteorology, climatology and disaster awareness and management.
- To conduct open classes to the different stakeholders
- To disseminate various weather information to the public through mass media.

Preparation of Work Plan for Phase 1 (Only Japanese)

Preparation of Monitoring Sheet Ver.1, Technology Transfer Plan and Project Brief Note

Preparatory explanation/ discussion on Work Plan/ Monitoring Sheet Ver.1

Preparation on Baseline Survey Report

Preparation of Monitoring Sheet Ver.2

Preparation of Final Report for Phase 1

Preparation of Work Plan for Phase 2 (Only Japanese)

Preparation of Monitoring Sheet Ver.3

Preparation of Monitoring Sheet Ver.4

Preparation of Monitoring Sheet Ver.5

Preparation of Final Report

Annex 3

Work Schedule

	Phase1												Phase2																								
	2014							2015												2016												2017					
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Baseline Survey: Capacity Assessment in Sri Lanka																																					
Understanding of the maintenance and management conditions of the meteorological observation equipment and the maintenance and management capability of the staff		■																																			
Current situation of the observation data transmission between the AWS sites and the DOM headquarters		■																																			
Understanding of the current condition of the GTS message switching system		■																																			
Evaluation of staff capability concerning meteorological forecasting		■																																			
Evaluation of staff capability concerning the dissemination of meteorological information (including educational activities) and communication technology		■																																			
Capacity on maintenance and calibration of meteorological observation equipment is improved.																																					
To review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved.		■			■																																
To procure the necessary instruments for calibration of meteorological equipment, and establish teams for proper maintenance and calibration.					■						■																										
To establish the traceability of meteorological instruments.	<Long-term expert's activity>																																				
To conduct training on calibration of conventional and AWS equipment	<Short-term expert's activity>										■					■					■		■				■				■		■				
To review and revise the Standard Operation Procedure for manual and AWS observation.					■						■					■					■																
To review and revise inspection and repairing (parts replacing) user's guide(s) for AWS											■					■					■																
To conduct trainings on the inspection and repairing of AWS											■					■					■		■				■				■		■				
To review the upper air observation schedule.	<Long-term expert's activity>																																				
Transmitting and receiving capacity of various kinds of meteorological data is strengthened.																																					
To review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved.		■			■																																
To examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.					■						■					■					■						■				■		■				
To review the current situation on GTS/MSS, and identify the issues to be improved.		■			■																																
To replace and upgrade the GTS/MSS.					■						■					■					■						■				■		■				
Capacity of weather forecasting is improved using obtained meteorological data																																					
To review the current situation on the weather forecasting and identify the issues to be improved.		■			■																																
To conduct the training on the development of Short Range and Weekly (7 days ahead) Weather Forecast Guidance and verification.					■																																
To produce Short Range and Weekly (7 days ahead) Weather Forecast Guidance at the selected stations.											■					■					■	■					■				■		■				
To produce Weather Forecast Guidance of Sea Wind at the selected stations.					■																	■					■										
To conduct the trainings on Satellite Animation and Interactive Diagnosis (SATAID)	<Short-term expert's activity>																																				
To review and improve the existing methods of seasonal precipitation forecast.					■						■					■					■	■					■				■		■				
To conduct on-the-job training on improvement of weather forecasting operation through integration of various data.											■					■					■	■					■				■		■				
Warning criteria is elaborated																																					
To review the current situation on warnings, and identify the areas to be improved.		■				■																															
To examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning.						■					■												■				■			■		■	■				
The method of dissemination and contents of meteorological information are improved.																																					
To review the contents of current meteorological information, and identify the issues to be improved.		■						■																													
To improve the contents of weather information.								■			■					■			■		■	■					■										
To review the timing of information dissemination to ships and fleet											■					■			■																		
To improve the contents of Website.								■			■					■			■		■	■															
To prepare smartphone compatible Website								■			■					■			■		■	■					■										
To conduct the training on responses to the mass media																						■					■										
To regularly update and maintain the products on the Website by the DOM.																						■					■										
To provide the rainings on update of the contents																						■					■					■					
To prepare the update operation manual for the products on the web pages																					■	■															
To prepare educational material (disaster awareness materials) for the weather services.		■						■			■					■			■			■					■					■	■				
To conduct open classes																																■	■			■	
Annual seminar																																			■		
Training in Japan																		□	□											□	□						

Annex 4

Expert Dispatch Schedule

						Phase	Phase 1												Phase 2																Phase 1		Phase 2		Total	
						Year	2014				2015								2016												2017											
						Month	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9				Man-Month		Man-Month		Man-Month	
	No.	Field	Name	Company	Rank																														Sri Lanka	Japan	Sri Lanka	Japan	Sri Lanka	Japan
Activity in Sri Lanka	1	Leader / Weather Forecasting	Yoshihisa UCHIDA	IMC	2	Original Plan	18					21					21				21			18			18			18			18				2.00	-	4.30	-	6.30	-
						Mobilized	18				19						23				21			21		30			22			17	8		7			2.00	-	4.20	-	6.20	-
	2	Weather Guidance	Nobutaka NOGUCHI	IMC	3	Original Plan	18					21					21				21			21			21			18			18			18			2.00	-	4.50	-	6.50	-
						Mobilized	18				19						23				21			21		21			21			31	8		10			2.00	-	4.43	-	6.43	-
	3	Meteorological Observation Technology	Toshihide ENDO	IMC	3	Original Plan	18				21					21					21			21			18			18					21			2.00	-	4.00	-	6.00	-
						Mobilized	18				22						20				21			21		18			24			31	7					2.00	-	4.07	-	6.07	-
					4	Original Plan																															0.00	-	0.00	-	0.00	-
						Mobilized																												1		11			0.00	-	0.40	-	0.40	-
	4	Data Management / Information Technology	Takanari FUJII	JWA	3	Original Plan	18					21					21					21			21			21								18			2.00	-	2.70	-	4.70	-
						Mobilized	18				21						21					21			20			13	13	14								2.00	-	2.70	-	4.70	-
	5	Weather Information Dissemination	Soshi IWATA	JWA	3	Original Plan	18				21					21					21			18			18			18			18			15			2.00	-	3.60	-	5.60	-
						Mobilized	18							21		21					18			24			26			15			18		7			2.00	-	3.60	-	5.60	-
	6	Website	Satoko NEGORO Motohiro YAMAUCHI	IMC	4	Original Plan							21				21				21			21			21			18			18			15			1.40	-	3.80	-	5.20	-
						Mobilized								21			21				21			21		30			24										1.40	-	3.20	-	4.60	-
	7	Project Coordinator / Weather Forecasting Assistant	Rashid ZAMAN	IMC	5	Original Plan											15										15								15				0.50	-	1.00	-	1.50	-
						Mobilized									15											19			11										0.50	-	1.00	-	1.50	-
																																			Original Plan Man-Month Total						11.90	-	23.90	-	35.80	-
																																			Mobilized Total						11.90	-	23.60	-	35.50	-
Activity in Japan	1	Leader / Weather Forecasting	***	IMC	2	Original Plan	3				1						2			1			2						2						2			-	0.30	-	0.35	-	0.65
						Mobilized	2 1				1						2			1			2						2			2	2					-	0.30	-	0.45	-	0.75
	2	Weather Guidance	***	IMC	3	Original Plan	3						3			3				3			3			3		1							2			-	0.45	-	0.60	-	1.05
						Mobilized	3				2	1				3				3			3			3		1				2						-	0.45	-	0.60	-	1.05
	3	Meteorological Observation Technology	***	IMC	3	Original Plan	3				2									2													2					-	0.25	-	0.20	-	0.45
						Mobilized	3				2									2												2						-	0.25	-	0.20	-	0.45
	4	Data Management / Information Technology	***	JWA	3	Original Plan	2														2														1			-	0.10	-	0.15	-	0.25
						Mobilized	2															2													1			-	0.10	-	0.15	-	0.25
	5	Weather Information Dissemination	***	JWA	3	Original Plan	2											3		3		3			2		2	5								2		-	0.25	-	0.85	-	1.10
						Mobilized	2											3		3		2					2	5								2		-	0.25	-	0.85	-	1.10
	6	Website	***	IMC	4	Original Plan							2								2														1			-	0.10	-	0.15	-	0.25
						Mobilized					2										2						5											-	0.10	-	0.35	-	0.45
	7	Project Coordinator / Weather Forecasting Assistant	***	IMC	5	Original Plan																26								26								-	0.00	-	2.60	-	2.60
						Mobilized																26		5	9	12												-	0.00	-	2.60	-	2.60
																																			Original Plan Man-Month Total						-	1.45	-	4.90	-	6.35
																																			Mobilized Total						-	1.45	-	5.20	-	6.65
			Report	Submission Schedule			G/R1 W/P				B/R			M/S2			F/R1		G/R2				M/S3			M/S4				M/S5				F/R2									

Legend ■ : Activity in Sri Lanka
□ : Activity in Japan

IMC: International Meteorological Consultant Inc.
JWA: Japan Weather Association

*Type of Report		
	G/R1	: Work Plan (Japanese)
	W/P	: Work Plan (Phase1) ／ Monitoring Sheet Ver.1
	B/R	: Baseline Survey Report
	M/S2	: Monitoring Sheet Ver. 2
	F/R1	: Project Completion Report (Phase1)
	G/R2	: Work Plan (Phase2)
	M/S3	: Monitoring Sheet Ver. 3
	M/S4	: Monitoring Sheet Ver. 4
	M/S5	: Monitoring Sheet Ver. 5
	F/R2	: Project Completion Report (Phase1)

Annex 5

Counterpart Trainings in Japan

Counterpart Trainings in Japan

(1) JICA C/P Training Programs arranged by the Consultant Team

<Name of the Counterpart Trainings>

First Training: Weather Forecasting & Weather Information Dissemination

Second Training: Weather Forecasting

<Participating Trainees>

4 personnel from the Operational Weather Forecasters of the Department of Meteorology (DOM), Sri Lanka.

< Training Contents and Schedule>

- First Training

Table: Summary of the First Training

Course Period	February 29, 2016 to March 15, 2016 (16 days)
Participants	1. Mr. JAYASEKERA Siri Ranjith (Director of Forecasting & Decision Support) 2. Mr. KARUNANAYAKE Athula Kumara (Deputy Director, Training Division) 3. Ms. JAYAKODY Preethika Madhavi (Meteorologist) 4. Mr. PEIRIS Thammahetti Mudalige Nandalal (Meteorologist)
Training Venues	JICA Chubu International Center (Nagoya), Gifu University, Nippon Television Network, Inc., and Life Safety Learning Center, Tokyo Fire Department, Japan Meteorological Agency (Otemachi), JICA Tokyo International Center (Hatagaya).
Training Contents	1. Learning the principles of the local meteorological forecast model and sea wave forecast model. 2. Understanding of the meteorology of turbulent flow in the surface boundary layer. 3. Understanding of the heat budget of meteorological phenomena and of the human body. 4. Understanding atmospheric pressure patterns and local meteorology as well

	as learning the classification method of atmospheric pressure patterns. 5. Weather Information Dissemination

Table: First Training Schedule

Date		Training Contents	Training Venues
1	28 February (Sun)	Colombo → Chubu Centrair International Airport, Nagoya	
2	29 February (Mon)	Orientation Briefing	JICA Chubu International Center (Nagoya)
3	01 March (Tue)	Local meteorological forecast model 1	Gifu University
4	02 March (Wed)	Local meteorological forecast model 1	Gifu University
5	03 March (Thu)	Sea wave forecast model	Gifu University
6	04 March (Fri)	Meteorology of surface boundary layer and turbulent flow	Gifu University
7	05 March (Sat)	Holiday (Excursion to heavy snowfall area: Shirakawago)	
8	06 March (Sun)	Holiday	
9	07 March (Mon)	Utilization of renewable energy (wind-power and solar power generation)	Gifu University
10	08 March (Tue)	Heat budget of meteorological phenomena and human body	Gifu University
11	09 March (Wed)	Local meteorology in Japan 1	Gifu University
12	10 March (Thu)	Local meteorology in Japan 2	Gifu University
13	11 March (Fri)	Classification of pressure pattern and regional meteorology (work study)	Gifu University
14	12 March (Sat)	Gifu →Tokyo	
15	13 March (Sun)	Holiday	
16	14 March (Mon)	Disaster experience learning center such as heavy rain and earthquake.	Life Safety Learning Center, Tokyo Fire Department

			(Oshiage)
		Weather information provision service by a commercial private broadcasting station	Nippon Television Network, Co. (Shinbashi)
17	15 March (Tue)	Courtesy call	Japan Meteorological Agency (Otemachi)
		JICA Evaluation Meeting	JICA Tokyo International Center (Hatagaya)
18	16 March (Wed)	Narita → Colombo	

Local meteorological forecast model 1 Training Course

Excursion to heavy snowfall area: Shirakawago

- Second Training

Table: Summary of the Second Training

Course Period	March 9, 2017 to March 23, 2017 (15 days)
Participants	1. Ms. WARNASOORIYA Anusha Rashanthi Patabedi (Deputy Director) 2. Mr. RATHUGAMAGE Malith Prasanna Fernando (Meteorologist) 3. Mr. PREMATHILAKE Jayasinghe Sepalage D. S. (Meteorologist) 4. Mr. KUMARA Athdath Waduge Susantha Janaka (Meteorologist)
Training Venues	JICA Chubu International Center (Nagoya), Gifu University in Japan, Tsukuba University in Japan, Japan Meteorological Agency (Otemachi), JICA Tokyo International Center (Hatagaya)
Training Contents	1. Learning the WRF (Weather Research and Forecasting) model and WRF Data Assimilation System (WRFDA) 2. Practice on the operation and tuning of the WRF model and WRFDA

Table: Second Training Schedule

Date		Training Contents	Training Venues
1	07 March (Tue)	Colombo →	
2	08 March (Wed)	→ Chubu Centrair International Airport, Nagoya	
3	9 March (Thu)	JICA Orientation Briefing	JICA Chubu International Center (Nagoya)
4	10 March (Fri)	Installation and Operation check of Linux and WRF	Gifu University
5	11 March (Sat)	Holiday	
6	12 March (Sun)	Holiday	
7	13 March (Mon)	Set up and Practical Run of WRF	Gifu University
8	14 March (Tue)	Sea Wave Forecast Model	Gifu University
9	15 March (Wed)	Drawing and Analyzing Output from WRF Model	Gifu University
10	16 March (Thu)	Local Climate Change in South East Asia Gifu → Takayama	Gifu University
11	17 March (Fri)	Highland Meteorological Observation and Data Acquisition Takayama → Gifu	Gifu University Takayama Observation Station
12	18 March (Sat)	Gifu → Tokyo →Tsukuba	
13	19 March (Sun)	Holiday	
14	20 March (Mon)	Understanding the WRFDA	Tsukuba University
15	21 March (Tue)	Set up and Practical Run of the WRFDA	Tsukuba University
16	22 March (Wed)	Evaluation of the WRFDA Practical Run and Tune-up Method	Tsukuba University
17	23 March (Thu)	Tsukuba → Tokyo Courtesy call	Japan Meteorological Agency (Otemachi)
		JICA Evaluation Meeting	JICA Tokyo International Center (Hatagaya)

18	24 March (Fri)	Narita → Colombo	

Sea Wave Forecast Model Training Course

Set up and Practical Run of the WRFDA Training Course

Courtesy call on Japan Meteorological Agency

(2) JICA C/P Training Programs arranged by the JICA HQs and the Long-term Expert

<Name of the Counterpart Training>

The 1st Program: Meteorological Instrument Calibration

The 2nd Program: Meteorological Observation

<Participating Trainees>

The 1st program: Staff in charge of meteorological instruments and electronics engineering of the DOM

The 2nd Program: Staff in charge of meteorological observations of the DOM

< Training Contents and Schedule>

- The 1st training Program

  Four staff of the DOM instrument division and the electronic division were trained in RIC-Tsukuba of JMA during two weeks in February 2016 in order to obtain the technique of meteorological instrument calibration as an unit of the activities 1.3 in the project "Establish the traceability of meteorological instrument" (Photo 2-1). Coupled with the short-term expert training courses in DOM, 'Meteorological Instrument Calibration 1' and 'Meteorological Instrument Calibration 2', the staff of the instrument division of DOM have obtained the full technique to make calibration of pressure and temperature instruments by themselves, and have started the new instrument calibration scheme in DOM.

  The contents of the 1st training are summarized in the following Table.

Table: Summary of the 1st C/P Training Program

Meteorological Instrument Calibration		
Outline of the training	Training Period	February 8, 2016 to February 19, 2016（12 days）
	Training Venues	Meteorological Instrument Center, JMA (RIC-Tsukuba) Head Quarters, JMA Tokyo Regional Headquarter, JMA
	Participants	■ Ms. WEERAPPERUMAGE DONA Liliyan Malani (Meteorological Officer in charge, Instrument Division) ■ Mr. METTASINGHE Napagoda Achchillage

		(Meteorological Officer Class, Instrument Division) ■ Mr. PRIYADHARSENA Wannakuwattawaduge Prasanna Kelum (Electronic Engineering, Electronic Engineering Division) ■ Mr. HATHTHOTUWA GAMAGE Prasanna Ranga Kumara (Telecommunication & Radar Technical Officer, Electronic Engineering Division)
Training purposes	1. Learning the techniques of meteorological instrument calibration 2. Acquiring information on meteorological obeservations	

Table: Schedule of the 1st Training

	Date 2016	Training Contents	Training Venues
1	7 February (Sun)	Colombo→Narita International Airport	
2	8 February (Mon)	JICA Briefing and orientation Training Orientation	JICA Tuskuba Int. Center RIC-Tsukuba
3	9 February (Tue)	Instrument calibration work Calibration of humidity, rainfall and wind measurement instrument	RIC-Tsukuba
4	10 February (Wed)	Calibration of thermometers and barometers Site visit to the radiosonde observation	RIC-Tsukuba
5	11 February (Thu)	Holiday	
6	12 February (Fri)	Visit to the surface observation site Lecture on meteorological observations Visit to the forecast and observation operation rooms	Head Quarters, JMA Tokyo Regional Headquarter, JMA
7	13 February (Sat)	Cultural visit to Tokyo	RIC-Tsukuba
8	14 February (Sun)	Cultural visit to Kamakura	RIC-Tsukuba
9	15 February (Mon)	Calibration of thermometer at the freesing point Testing of phygrometers using the Assmann phygrometer	RIC-Tsukuba
10	16 February (Tue)	Calibration of thermometer at the thermal bath	RIC-Tsukuba
11	17 February	Calibration of barometers	RIC-Tsukuba

	(Wed)		
12	18 February (Thu)	Practice on calibrations of barometers and thermometers	RIC-Tsukuba
13	19 February (Fri)	Production of calibration manual of barometers and thermometers Evaluating the training and awarding certificates	RIC-Tsukuba JICA Tsukuba Int. Center
14	20 February (Sat)	Narita International Airport→Colombo	

- The 2nd training Program

  This program was designed for the DOM staff to learn the latest knowledge on meteorological observations for planning the modernization of DOM weather services. The number of the trainees was increased from the originally planned 4 people to 8 people so that staff at various levels such as from a deputy director to heads of the regional offices of DOM could discuss the modernization. The training program was implemented by the staff of JMA and a meteorological instrument manufacturer, and a professor of Kyoto University specialized in meteorological observations during two weeks in February 2017. At the end of the training, all the trainees discussed problems and issues in promoting the modernization of the meteorological observations in the future DOM, and compiled a proposal as the final report, and submitted it to the Director General of DOM after their return to Sri Lanka.

  The contents of the 1st training are summarized in the following Table.

Table: Summary of the 2nd C/P Training Program

Meteorological Observations		
Outline of the training	Training Period	February 13, 2017 to February 24, 2016 (12 days)
	Training Venues	JICA Tokyo International Center Head Quarters, JMA Tokyo Regional Headquarter, JMA Aerological Observatory, JMA Meteorological Instrument Center, JMA (RIC-Tsukuba) Kumagaya Local Meteorological Observatory Meisei Isesaki Factory
	Participants	■ Mr. A. G. M. M. Wimalasooriya (Deputy Director in charge of meteorological instruments) ■ Mr. P. A. A. Priyantha (Meteorologist, Computer Division)

		■ Ms. K. G. P. S. Wijerathne (Meteorological Officer, Radar Division) ■ Ms. G. R. L. Palihapitiya (Meteorological Officer, National Meteorological Centre) ■ Mr. D. M. Podibanda (Meteorological Officer, Kurunegala Regional Office) ■ Ms. M. B. Iranganie (Meteorological Officer, Puttalam Regional Office) ■ Ms. T. D. Malani (Communication Officer, Communication Divison) ■ Mr. W. A. T. K. Palitha de Silva (Telecommunication & Radar Technical Officer, Electronic Divison)
Training purposes	Acquiring knowledges on the latest technology of meteorological observations in order to make plan of the modernization of meteorological observation of the DOM	

Table: Schedule of the 2nd Training

	Date 2017	Training Contents	Training Venues
1	12 February (Sun)	Colombo→Narita International Airport	
2	13 February (Mon)	JICA Briefing and orientation Training Orientation	JICA Tokyo Int. Center
3	14 February (Tue)	Meteorology for surface observation Manual surface observation	
4	15 February (Wed)	Automated surface observation	
5	16 February (Thu)	Operation of automated surface observation Data quality check	
6	17 February (Fri)	Visit to the surface observation site Lecture on remote-sensing observations Visit to the observation operation rooms	Head Quarters, JMA Tokyo Regional Headquarter, JMA
7	18 February (Sat)	Cultural visit to Kamakura	
8	19 February (Sun)	Tokyo→Kumagaya	
9	20 February (Mon)	Services of regional meteorological observatories of JMA	Kumagaya Local Meteorological Observatory, JMA

		Manufacturing of meteorological instruments	Meisei Isesaki Factory
10	21 February (Tue)	Lecture on the JMA meteorological satellite Site visit of the Doppler Radar for Aviation Weather Haneda→Tsukuba	Head Quarters, JMA Haneda International Airport
11	22 February (Wed)	Upper-air observation Meteorological instrument calibration Tsukuba→Tokyo	Aerological Observatory RIC-Tsukuba
12	23 February (Thu)	Analysis on thecurent situations of the meteorological observation in Sri Lanka Discussion on the modernization of the meteorological observation in Sri Lanka	JICA Tokyo Int. Center
13	24 February (Fri)	Planning of the modernization of the meteorological observation in Sri Lanka Evaluating the training and awarding certificates	JICA Tokyo Int. Center
14	25 February (Sat)	Narita International Airport→Colombo	

The photos of the trainers and trainees in the 1st and 2nd C/P training Programs are shown in Photo.

Photo The trainees, trainers and training conductors of the JICA C/P training program 'Meteorological Instrument Calibration (left)' and 'Meteorological Observations (right)'.

Annex 6

Provision of Equipment

Provision of Equipment

(1) The Equipment procured by the Consultant for the activities of each expert and provided to the DOM under the Project is listed in the following table.

Table: List of Equipment Provided Under the Project (Procured by Consultant Team)

No.	Name of Equipment	Manufacturer	Model	Purpose	Q'ty	Installation Place	Procurement Date
Phase 1							
1	Wireless Router	D-Link	DWR-113	For Internet Access (Forecasting Room)	1	DOM Head Office	October 04, 2014
2	Laminator (A3)	BIOSYSTEM	SOUL 330C	For the distribution of Weather Information Dissemination Products	1	DOM Head Office	January 15, 2015
3	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	2	DOM Head Office	January 16, 2015
4	Laptop PC for Establishment of Website	DELL	Inspiron 5000 (17inch)	For the conduct of the Training for Website creation and maintenance	1	DOM Head Office	January 16, 2015
5	Laptop PC for Conduct of Training on, Weather Guidance	DELL	Inspiron 5000 (15inch)	For the conduct of Training on Weather Guidance	7	DOM Head Office	January 17, 2015
6	Laptop PC for the Download of Observation Data	DELL	Inspiron 5000 (15inch)	For the distribution of Weather Information Dissemination Products	1	DOM Head Office	January 17, 2015
7	Monitor for Weather Briefing	SHARP, etc.	SHPLC60LE650, etc.	For the conduct of Weather Briefing	1	DOM Head Office	January 19, 2015

8	Additional Lightning Protection System	-	-	For the strengthening of the AWS Lightning Protection	3	Polonnarumwa, Aralaganwill and Ratnapura Observation Stations	January 30, 2015
9	Multifunction Machine (Printer/Photocopy)	CANON	IR2545	For the copy and printing of Training Material and Products	1	DOM Head Office	March 13, 2015
10	Website Template Program	JB TECH ENGINEERING	Joomla 3.4 Compatible	For the production of the Website	1	DOM Head Office	June 21, 2015
11	Spare Parts for the AWS - Data Logger - Wind Direction and Speed Sensor - Temperature Sensor - Rain Gauge - Pressure Sensor - Hygrometer - Cap for Humidity Transmitter - Solar Radiation Sensor	 MEISEI VAISALA MEISEI MEISEI VAISALA VAISALA VAISALA EKO	 113115-001 WMT-700 , MES-39457 MES-39459 PTB-330A HMT-333 DRW010281SP MS402	For the maintenance of the AWS	 2 4 1 1 1 1 10 1	DOM Head Office	July 8, 2015
12	Standard Meteorological Instrument (Electric Temperature Sensor)	CHINO	CAB-F201-2, R900-F25AD	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015
13	Standard Meteorological Instrument (Electric Pressure Sensor)	VAISALA	PTB330TS, M170	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015

14	Portable Calibration System (Portable AWS)	VAISALA, DELAIRCO, etc.	PTB330A, DLM, etc.	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 8, 2015
Phase 2							
15	Laser Pointer	KOKUYO	ELP-G10	For Training and Open Class	1	DOM Head Office	December 1, 2015
16	Sound System for Open Class	YAMAHA, ELECTRO VOICE, etc.	Stagepass 400i, etc.	For Open Class	1	DOM Head Office	December 14, 2015
17	Projector with Screen for Open Class	EPSON, etc.	EB-W04, etc.	For Open Class	1	DOM Head Office	May 07, 2016
18	Cooler Box	LION STAR	22L	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 2, 2016
19	Extension Power Code	CABLE REEL	30m	For Open Class	1	DOM Head Office	July 4, 2016
20	Ice Shaving Machine	CHUBU CORPORATION	Hatsuyuki HA-110S	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
21	Thermometer Inspection Bath	THOMAS KAGAKU	Celsius 100L	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
22	Barometer Calibration Device	DAIICHI KAGAKU	112704878-004-1	For the calibration of the Meteorological Instrument	1	DOM Head Office	July 22, 2016
23	Spare Parts for the AWS - Data Logger - Temperature Sensor - Rain Gauge - Pressure Sensor - Hygrometer - Cap for Humidity	 MEISEI MEISEI OGASAWARA VAISALA MEISEI VAISALA	 113115-001 MES-39457 RS-102N1 PTB-330A MES-39458 DRW010281SP	For the maintenance of the AWS	 2 3 3 3 3 10	DOM Head Office	July 22, 2016

	Transmitter - Solar Radiation Sensor - Surge Arrester for Power - Surge Arrester for LAN - GPS Antenna for Data Logger	 EKO MORINAGA SANKO POSITION	 MS402 ALPK-VNJ2P LAN-100IS GA-08R (3M) BNC		 3 2 2 2		
24	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	1	DOM Head Office	November 05, 2016
25	Printer (A3 Inkjet)	HP	Officejet 7110	For the printing of Training Material and Products	1	DOM Head Office	November 11, 2016
26	Hard Disk (4T)	Western Digital Corporation (WD)	MY PASSPORT	For the WRF Data Storage	1	DOM Head Office	April 06, 2017
27	Projector Stand	Shonzon Screen Works	Portable Tripod Projector	To set a projector at appropriate place promptly	1	DOM Head Office	May 29, 2017

(2) The Equipment procured by the Long-term Expert and provided to the DOM under the Project is listed in the following table.

Table: Lists of Equipment Provided Under the Project（Procured by Long Term Expert）

No.	Name of Equipment	Manufacturer	Model	Purpose	Q ' t y	Imstallation Place	Procurement Date
1	Camera	Nikon	D3300 Camera with 18-55mm VR II Lens	For the recording of project activities	1	DOM Head Office	January 7, 2015
2	Laptop computer	HP	Pavilion 15-P022tu	For the production of	1	DOM Head Office	January 16, 2015

			Core i3-4030U Notebook	training documents			
3	Multi-function Printer	Canon	iC MF 8580 CDW Multi-function Machine	For the printing training documents	1	DOM Head Office	February 5, 2015
4	Projector	Epson	Epson Multi- Media Projector	For the projecting training materials	1	DOM Head Office	March 12, 2015
5	Vehicle	Toyota	Hilux 4WD Double Cab including canopey	For the of survey of regional offices of DOM	1	DOM Head Office	March 31, 2015
6	GPS Receiver	Garmin	GPS eTrex 30	For the survey of identifying latitudes and longitudes of meteorological instruments	1	DOM Head Office	October 15, 2015
7	Freezer	Candy	Chest Freezer	For the producing ice to make freezing point calibration of thermometers	1	DOM Head Office	June 21, 2015
8	Air conditioner	Panasonic	S24RKH%6938905 133	For the air conditioning of the training center of DOM	2	DOM Head Office	August 11, 2016
9	Air conditioner	Panasonic	S24RKH%6938905 133	For the air conditioning of the training center of DOM	2	DOM Head Office	December 12, 2016
10	Digital Barometer	Vaisala	PTB330TS & Indicator M170	For the sub-standard of pressure	1	DOM Head Office	March 17, 2017
11	Printer	Canon	ImageCLASS LBP-8100n	For the printing weather charts to be connected with	1	DOM Head Office	August 18, 2017

				the GTS/MSS terminal			

(3) The Equipment procured by JICA and provided to the DOM under the Project is listed in the following table.

Table: List of Equipment Provided Under the Project (Procured by JICA)

No.	Name of Equipment	Manufacturer	Model	Purpose	Q'ty	Installation Place	Procurement Date
1	GTS Message Switch System	ESS Weathertech Pty Ltd.	GTS Message Switch System	For the Exchange of Meteorological Information	1	DOM Head Office, Colombo International Airport and Mattala Rajapaksa International Airport	December 18, 2015
2	HimawariCast Reception System	Delairco Japan KK	HimawariCast Reception System	For receiving the Himawari-8 data	1	DOM Head Office and Colombo International Airport	August 16, 2017

Annex 7

Minutes of Meeting for the Joint Coordinating Committees (JCCs)

Minutes of Meeting for the 1st Joint Coordinating Committees (JCCs)

ආපදා කළමනාකරණ අමාත්‍යාංශය
அனர்த்த முகாமைத்துவ அமைச்சு
MINISTRY OF DISASTER MANAGEMENT
Vidya Mawatha, Colombo 07, SRI LANKA

Minister 2665401 Fax 2665386 Secretary 2665389 Fax 2665898 General Office 2663170 Fax 2663170

My No. SDM/PROJECT/JCC/MINUTES/LANDSLIDE/2014 Your No.

Date 22.12.2014

The Chief Representative
The Japan International Cooperation Agency
Sri Lanka Office

Minutes of meeting on Joint coordination committee (JCC) for Technical cooperation project for " Improving of Meteorological Observation, Weather Forecasting and Dissemination" and "Landslide Mitigation Projects"

Two copies of the above meeting minutes which are signed by the Secretary are been sent herewith for necessary action please.

Wasantha Samaraveera
Additional Secretary
For Secretary

Copy :

Director General - Department of Meteorology – f.n.a
Director General - NBRO – f.n.a.

MINUTES OF MEETING
ON
JOINT COORDINATION COMMITTEE (JCC)
FOR
TECHNICAL COOPERATION PROJECT
FOR
"IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION"
AND
"LANDSLIDE MITIGATION PROJECT"
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

The series of discussions on the above captioned project among the officials concerned of the Government of Sri Lanka and the Japan International Cooperation Agency (JICA) Sri Lanka Office have been conducted under chairmanship of Ms. S M. Mohamed, Secretary to the Ministry of Disaster Management.

As the result of the discussions, both sides have confirmed the main items described in the attached sheet.

Colombo, December 19, 2014

Kiyoshi Amada
Chief Representative,
The Japan International Cooperation Agency
Sri Lanka Office

S. M. Mohamed
Secretary
The Ministry of Disaster Management

Witness:

Lalith Chandrapala
Director General
The Department of Meteorology

Asiri Karunawardena
Director General
The National Building Research Organization

ATTACHMENT

1. Date and Venue of Joint Coordination Committee

   1) Date: Tuesday, October 14th 2014
   2) Time: 14:00hrs to 17:00hrs
   3) Venue: Conference Room of Ministry of Disaster Management
   4) Agenda: As per attached.

2. Main Points Discussed

   1) Welcome Address by Secretary to the Ministry of Disaster Management

      Secretary, Ministry of Disaster Management welcomed JICA officials, JICA Experts and relevant officers from Department of Meteorology, National Building Research Organization and Disaster Management Centre.

      She appreciated the past cooperation projects from Japan and JICA, which fulfilled the gaps existed in Disaster Risk Reduction. Though the project formulation took several years, she re-iterated her confidence that both projects would produce satisfactory results. She also expressed that meaningful and fruitful discussions are required for successful implementation of the project.

      Therefore, she appreciated the conduct of JCC meetings every quarter and requested to conduct On-The-Job (OJT) Training to relevant officers for the sustainability of the projects. Based on the signed Record of Discussion (R/D), she requested the JICA Experts to transfer their skills and knowledge to counterparts to sharpen their skills.

   2) Opening Address by JICA Chief Representative

      JICA Chief Representative appreciated the cooperation between Sri Lanka and Japan to inaugurate both projects. While thanking all the related officers, he expected smooth and successful implementation of the Project as these two projects are mentioned in the Joint Statements of Japanese Government and Sri Lankan Governments.

   3) Explanation of the Work Plan on the Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination

      Sri Lankan side indicated the following points for successful implementation of the project.

      - The importance of the supply of the required equipment for the project as indicated in the Record of Discussions (R/D).
      - Request to provide the ID and password of data for SATAID by Japan Meteorological Agency through JICA.
      - To keep the first two years for mainly the project implementation and the third year for monitoring/verification.

      JICA Sri Lanka responded to the above inquiries as follows.

      - JICA Sri Lanka will reconfirm the equipment to be procured in line with R/D.
      - JICA Sri Lanka will contact JMA through JICA HQ and ask for ID and password of SATAID data.
      - JICA Expert team indicated the schedule of weather forecasting and warning activities has been considered so that the first two years for mainly the project implementation and the third year for mainly verification of the accuracy and appropriateness.
      - JICA expert team requested hazard information available at NBRO and NBRO agreed to provide them.

   4) Explanation of the Work Plan on the Technical Cooperation for Landslide Mitigation Project

      Sri Lankan side indicated following points for the successful implementation of the project:

      - To expedite the survey and design process in order to start physical construction before the next monsoon season, which starts next April.
      - Include the DMC staff when conducting OJT training on Early Warning.
      - Conduct trainings in Japan in the early first and second year, rather than having one in year 2016 and 2017.
      - Since the four pilot sites are ear-marked by JICA out of 46 places approved by the cabinet, Sri Lankan side wishes to have the early implementation of the physical mitigation works in the project as the pattern of the rainfall changes.

      JICA Sri Lanka responded to the above inquiries as follows.

      - JICA and JICA Expert team will try their best to meet the request from Sri Lankan side for expediting the physical works.
      - JICA and JICA Expert team agreed to include DMC staff to conduct OJT on Early Warnings.
      - JICA Expert team will reconsider the timing of trainings in Japan.

- JICA Expert team asked about the procedure of utilizing UAV for surface observation. Sri Lankan side agrees to take necessary arrangement for UAV usage with Ministry of Defense and Urban Development, Sri Lankan Air Force and Civil Aviation Authority.

5) Revision of Project Design Matrix (PDM)

While the percentage mentioned in the revised PDM is set below 100%, based on the request of Sri Lankan Side, JICA Expert team assured to conduct OJT to all the staff concerned in the project. Proposed revision of the PDM was approved as per attached (Annex 2).

6) Project Launch

Both the Sri Lankan Side and JICA side agreed to organize Project Launch for both project. Date of the Launch should be late November or early December as budget related works finish in middle of November.

Both sides agreed to have further discussion to finalize the date.

7) Next JCC Meeting

Chairperson has informed that next JCC meeting to be organized in January 2015.

Annex:

1. Agenda of JCC

2. PDM version 1

3. List of Attendants

Annex 1

Agenda on Joint Coordinating Committee for "Landslide Mitigation Project" and "Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination"

Date: 14th October, 2014

Venue: Conference Room, Ministry of Disaster Management

Time: 14:00 -

1. Opening Address: Secretary, Ministry of Disaster Management
2. Opening Remarks: Chief Representative, JICA Sri Lanka
3. Explanation of Work Plan: DoM project expert team
4. Explanation of Work Plan: NBRO project expert team
5. Revision of PDM: DoM project
6. Revision of R/D (Assignment of Counter Part and other necessary revision): Both project
7. Launch of the project: Both project
8. Closing remarks

END

Annex 2

Project Design Matrix: PDM

Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination

Version 1 as of 14th October 2014

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1. Traceability of meteorology instruments (Availability of national standards frequency of inspection) 2. Number of missing observation data 3. Accuracy of rainfall forecast in the selected stations 4. Number of selected station where weekly forecast is enabled in trial basis	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened 3. Capacity of weather forecasting is improved using obtained meteorological data 4. Warning criteria is elaborated. 5. The method of dissemination and contents of meteorological information are improved.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project 1.2 Training on inspection and repairing of AWS is conducted for XX% of the relevant DOM staff Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff 2.1 Data from AWS are obtained and made available to a full extent in DOM. 2.2 Binary data via GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least XX persons in the DOM obtain the ability to conduct weather guidance At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance 3.2 At least XX persons in the DOM obtain the ability to forecast short range sea surface wind. At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM website is increased by XX% or more. Monthly access number of the DOM Website is increased by 50% or more	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM - The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the short range forecast - Training records on the weekly range forecast - Draft warning criteria - Educational material for weather services	Necessary budgets for maintaining meteorological equipment are allocated to DOM in 2015 and 2016
Activities	Inputs		

	Japan's side	Sri Lanka side	
	Long-term expert Chief Adviser / Expert of Weather Services Short-term experts - Expert of Meteorological Observation - Expert of Satellite Data Analysis Experts dispatched from the counterpart - Leader / Expert of Weather Forecasting - Expert Weather Guidance - Expert of Meteorological Observation Technology - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant Machinery and Equipment - Laptop PC for the training of weather guidance method - Laptop PC for downloading data from AWS server - Display for Weather Briefing - Multifunction machine (Printer / Photocopy) - Printer - Portable Calibration System (Portable AWS) - Standard Meteorological Instrument (electric-temperature and pressure sensor) - Spare parts for AWS	Administration Project Director, Project Manager Counterpart personnel - C/P personnel from the relevant divisions under DOM Facilities and Equipment - Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment Budgetary Arrangement by DOM Administrative and local operation costs	Pre-conditions: The appropriate counterpart personnel to participate in a series of training provided by the Project are secured
1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 2.1 2.2 2.3 2.4 3.1 3.2 3.3 3.4 3.5 3.6 3.7 4.1 4.2 5.1 5.2 5.3 5.4 5.5 5.6	Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved Prepare the necessary instruments for calibration of meteorological equipment and establish term(s) for proper maintenance and calibration. Establish the traceability of meteorological instruments Conduct training on calibration of conventional and AWS equipment Review and revise the Standard Operation Procedure for maintenance and calibration of conventional and AWS observation Review and revise inspection and repairing (part-replacing) user's guide for AWS Conduct training on inspection and repairing of AWS Review the upper air observation schedule Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved Estimate the backup mode for the data transmitting and receiving between AWS sites and the headquarters Review the current situation on GTS/MSS, and identify the issues to be improved Replace and upgrade the GTS/MSS Review the current situation on weather forecasting and identify the issues to be improved Conduct training on development of weather guidance products for short range (36 hrs) and weekly weather forecast including their forecast verification techniques Conduct the training on the development of short range (with 12 hour precipitation up to 36 hour) and weekly (with 7 days) digital weather guidance and verification Prepare weather guidance products for short range and weekly at the selected stations Produce short range (every 12 hour precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance in the selected stations Conduct training for short range and surface wind forecast utilizing satellite data Produce weather forecast guidance of sea wind at the	Lamantine nuclaine - Laptop PC for the training of editing a web page - Software for editing a web page - Public Address System for Open Class - Public Address Sound Reinforcement System - Projector for Open Class - Stone bulb for Projector - Extension power cable for Open Class - GTS/Message Switching System	

observing stations
3.5 Conduct training on Satellite Animation and Interactive Processing Method (SMAP)
3.6 Review and evaluate the seasonal weather forecasting methods
Survey and improve the existing methods of seasonal precipitation forecast
3.7 Conduct on-the-job training on improvement of weather forecasting operations through integration of various data
4.1 Review the current situation on warnings, and identify the area to be improved
4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and prepare criteria for heavy rainfall, strong winds and occurrence of lightning
Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning
5.1 Review the contents of current meteorological information and identify the issues to be improved
5.3 Improve the contents of meteorological information
5.4 Improve the manner of information dissemination to ships and fleet
5.4 Improve the contents of website of the headquarters.
Improve the contents of website
5.5 Prepare smartphone compatible website.
5.6 Prepare educational material (ex. website, CDs, leaflet and publications) on the weather services
Prepare educational material (ex. website, CDs, leaflet and publications) on the weather services | | |

Remarks: Indicators should be refined upon the completion of the baseline survey that is to be conducted during the initial 3 months of the project implementation.

Annex 3

LIST OF ATTENDANCE

JOINT COORDINATING COMMITTEE (JCC)
FOR
TECHNICAL COOPERATION PROJECT
FOR
"IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION"
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Location: Conference Room, Department of Meteorology
Time: 1400 hrs , October 14, 2014

No.	Name	Position	Signature
1	S. M. Mohamed.	Secy	
2	Lalith Chandrapala	DG, DOM	
3	MAJ-GEN. A.B.R.MACK (Retd)	DG. DMC	
4	Asst. Commandant	P.M NBRO	
5	R.H.S. Bandara	D/Legend. Mgr	
6	K H M S Premalal	Director (DOM)	
7	Nuwan Kumarasinghe	E/Engineer (DOM)	
8	J. D. G. Senanyake	Assistant Director	
9	A.L. Riyas	Engineer	
10	Kyoshi Kawakami	JICA Expert	

11	Ryuichi HARA	JICA Expert for TLMP	
12	Keiichi HINDI	JICA EXPERT	
13	Kohetana NOGUCHI		
14	Takanori FUJII		
15	Toshihide ENDO	JICA Expert	
16	Soshi IWATA	JICA Expert	
17	Yoshihisa UCHIDA	JICA Expert	
18	Masahito Ishihara	JICA Expert	
19	Toshiyuki Shimano	Representative JICA Sri Lanka	
20	Kiyoshi AMADA	Chief Representative JICA Sri Lanka	
21	J. D. G. Senanyake	Assistant Director ERD	
22			
23			
24			
25			

Minutes of Meeting for the 2nd Joint Coordinating Committees (JCCs)

MINUTES OF THE MEETING
OF THE
JOINT COORDINATION COMMITTEE (JCC)
FOR THE
TECHNICAL COOPERATION PROJECT
ON THE
"IMPROVEMENT OF THE METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION"
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

The series of discussions on the above captioned project among the officials concerned of the Government of Sri Lanka and the Japan International Cooperation Agency (JICA) Sri Lanka Office have been conducted under the chairmanship of Mr. S. S. Miyanawala, Secretary of the Ministry of Disaster Management. As the result of the discussions, both sides have confirmed the main items described in the attached sheet.

Colombo, November 18, 2016

Chief Representative,
Japan International Cooperation Agency
JICA Sri Lanka Office

Lalith Chandrapala
Director General,
Department of Meteorology (DOM)

ATTACHMENT

1. Project Name

Technical Cooperation Project for the Improvement of the Meteorological Observation, Weather Forecasting and Dissemination in the Democratic Socialist Republic of Sri Lanka

2. Implementing Agency

Ministry of Disaster Management, Department of Meteorology (DOM), Sri Lanka and the Japan International Cooperation Agency (JICA)

3. Presentation of the Project Progress by the Project Manager of DOM

Director (project), Department of Meteorology presented the progress of the project. On average 80% of the project has been completed and still there are some mismatching with the development of warning criteria. Copy of the presentation is attached as annex 2.

4. Presentation of the Project Progress by the JICA Long Term Expert

As shown in Annex 3, the JICA long term expert described the activities of establishment of the traceability of meteorological instruments and reviewing the upper-air observation schedule. He reviewed tow training courses in Japan on instrument calibration and weather forecasting, and also showed three training programs planned in DOM by short-term experts on tropical meteorology, as well as the lecture on basic meteorology by the long term expert. He particularly stressed the importance of implementation of the daily upper radiosonde observation in Sri Lanka, which is currently made three times a week.

5. Introduction of the Project Products by the DOM and the Consultant Expert Team

the JICA consultant team gave to each of the attendees some of the major project products such as the DVD of the Disaster Awareness Cartoon entitled "Save Yourself," EP1: Climate of Sri Lanka, EP2: Thunderstorm and Lightning, EP3: Heavy Rain and Disaster), a rubber DOM mascot, leaflets and the Beaufort Scales of Land and Sea (Shinhala, Tamil and English) and showed EP2: Thunderstorm and Lightning for a few minutes.

6. Relevant Items Discussed

The following discussions were held between the DOM and the JICA expert team together

with the long term JICA expert for the project activities.

Activity 1: Capacity on the maintenance and calibration of meteorological observation equipment is improved.

The long term JICA expert emphasized the significance of the establishment of the traceability of wind and rainfall measurements in the DOM and also recommended the replacement of the existing aluminum screens with wooden screens in order to improve the performance of the existing thermometer screens of AWS against solar radiation. The DOM agreed to this comment and recommendation.

Activity 2: Transmitting and receiving capacity of various kinds of meteorological data is strengthened

The JICA consultant team requested the DOM to provide the information on the progress of the tender result of the procurement for IP-VPN Service for the existing AWS observation network in lieu of the existing VSAT network and the schedule of transition from the existing VSAT network to the new IP-VPN. The DOM mentioned that the IP-VPN Service provider would be selected by March 2017 and the transition from the existing VSAT network to the new IP-VPN should immediately commence after the selection.

The JICA consultant team noted the necessity of the official request of the DOM to the India Meteorological Department for the provision of meteorological data through GTS in the "Binary Universal Form for the Representation of Meteorological Data (BUFR)." The DOM replied that the request has already been made and that they would make a follow-up. In addition, the DOM mentioned that an alternative such as the Thai Meteorological Department might be considered in lieu of the India Meteorological Department.

The JICA consultant team further noted that the training on Moving Weather module to access WAFS data via the Secure SADIS FTP has already been approved by the JICA Head Office and is scheduled to be conducted in 2017 after meteorological data through GTS in the "Binary Universal Form for the Representation of Meteorological Data (BUFR)" coming to the National Meteorological Center, Colombo has been transferred.

Activity 3: Capacity of meteorological forecasting is improved using obtained meteorological data.

The JICA consultant team emphasized the importance of the continuous operation of the Numerical Weather Prediction (NWP) model of the DOM (WRF) by a high speed computer

system, establishment of easy acquisition environment of the required Numerical Weather Prediction value and also the development of more qualified technical personnel for the Numerical Weather Prediction (NWP) model for the establishment of automatic weather forecast guidance in the DOM. The DOM has completely agreed with all the recommendations made by the team.

Activity 4: Warning criteria is elaborated

The JICA consultant team introduced the newly proposed Warning/Advisory Criteria of Heavy Rain and Warning/Advisory Signs (Heavy Rain, Strong Wind, Lightning, Cyclone and Tsunami) which conform to the "Universal Design" and which is a result of the data analysis of the events caused by strong wind in Sri Lanka. In addition, the JICA consultant team recommended to the DOM to request the Disaster Management Center to indicate accurate occurrence time and location (latitude and longitude) of each event in the disaster database for effective utilization of the disaster database by many sectors.

Activity 5: The method of dissemination and contents of meteorological information is improved.

The JICA consultant team introduced the following options to be made in 2017 by the team and the DOM together in order to increase the number of access to the new DOM Web site.

- Distribution of leaflets (flyers) to promote the DOM URL to visitors including students who attended the school trips and open classes.
- Embedding the link of the DOM Web Site in the weather forecasting videos available in Youtube.
- Establishment of more external links from Web Sites to be accessible by users who require weather information (golf courses, ferry terminals, TV stations, airport, hotels, wedding halls, sports stadiums, tourism sector, government authorities, JICA Sri Lanka office's Facebook page) through the provision of a banner icon to link the new DOM Web Site.
- Improvement of the new DOM Web Site's placement on the major search engine results.

The JICA consultant team requested the DOM to select the schools where the Open Classes would be conducted and to make necessary arrangements and appointments with the schools selected. The DOM positively agreed to the requests and indicated to conduct the Open Classes together with the team.

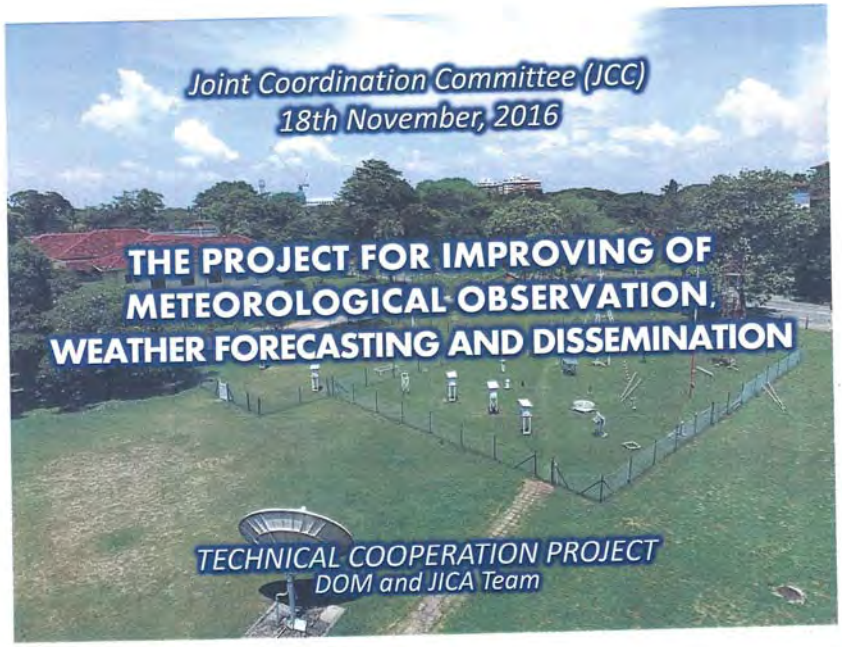
7. JICA Senior Representative appreciated the cooperation between Sri Lanka and Japan

regarding the Technical Cooperation Project.

8. The Secretary of the Ministry of Disaster Management and Director General of the Department of Meteorology indicated their appreciation to the JICA officials.

Annex 1: List of Attendees of the JCC
Annex 2: Presentation file of the project progress by the Project Manager of the DOM
Annex 3: Presentation file of the project progress by the JICA Long Term Expert

Annex 2



Title of the Project

The Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination

Overall Goal

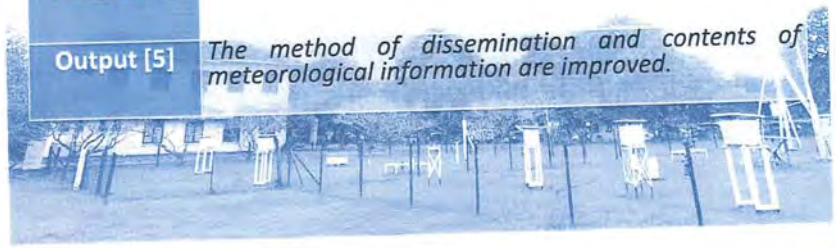
Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.

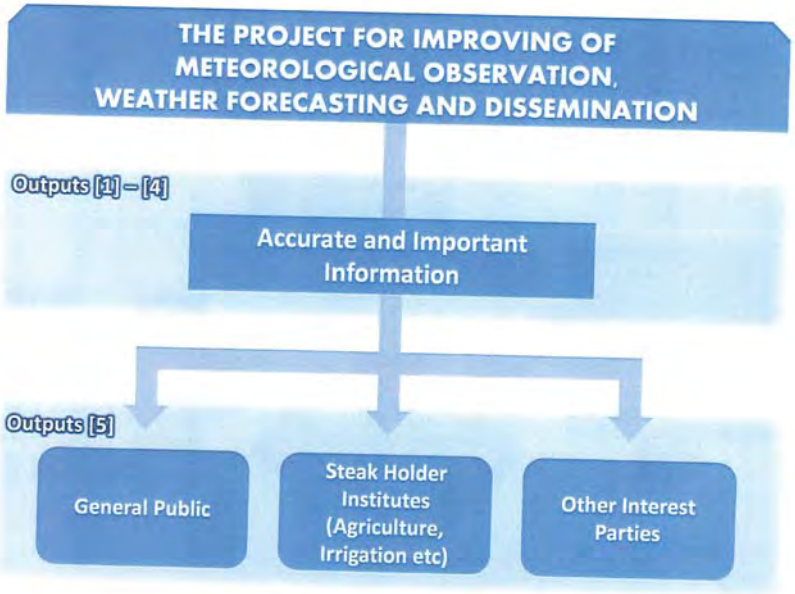
Project Purpose

More accurate and timely meteorological information is disseminated to the public and the disaster related organizations.

Main Outputs

Outputs	Result
Output [1]	*Capacity on maintenance and calibration of meteorological observation equipment is improved.*
Output [2]	*Transmitting and receiving capacity of various kinds of meteorological data is strengthened.*
Output [3]	*Capacity of weather forecasting is improved using obtained meteorological data.*
Output [4]	*Warning criteria is elaborated.*
Output [5]	*The method of dissemination and contents of meteorological information are improved.*





Outputs [1] –[4]

Output [1]
Observation

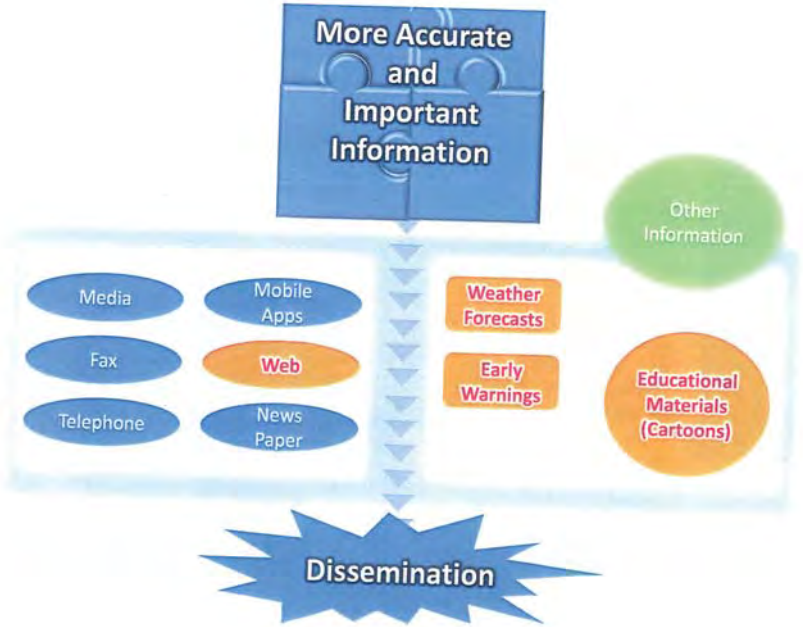
Output [2]
Communication

Output [3]
Forecast in Different Scales

Output [4]
Warning Criteria
Early Warnings

Information Prepared by DOM

More Accurate and Important Information



Output [1]
Meteorological Observation

Activities

- Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved.
- Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration.

JICA Team with the help of DOM

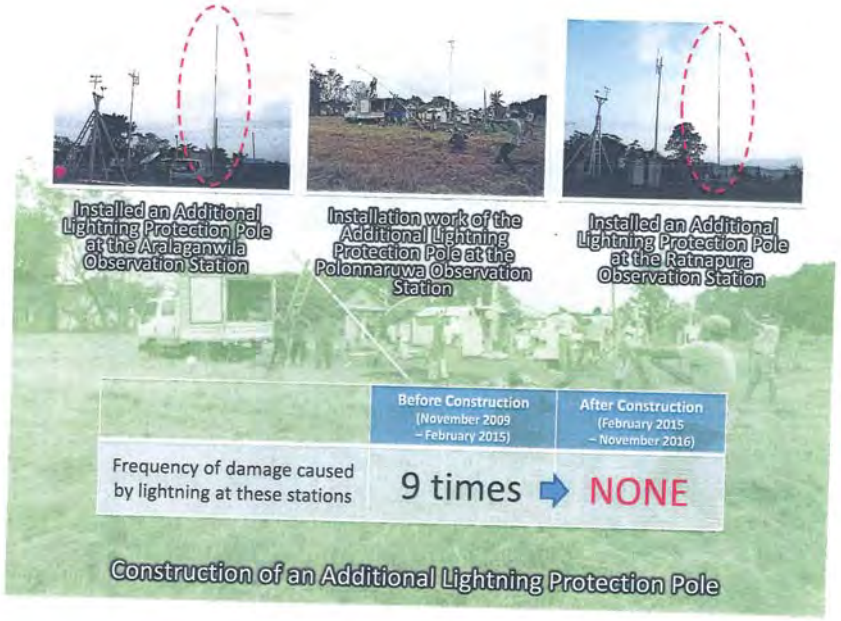
- Review and revise the Standard Operation Procedure for manual and AWS observations.
- Review and revise inspection and repairing (parts replacing) user's guide for AWS.
- Conduct training on inspection and repairing of AWS.

JICA Team & DOM

- Establish the traceability of meteorological instruments.
- Conduct training on calibration of conventional and AWS equipment.
- Review the upper air observation schedule.

DOM with the help of JICA Team


Observing Data Logger
Measurement of Earth Resistance


Installed an Additional Lightning Protection Pole at the Aralaganwila Observation Station
Installation work of the Additional Lightning Protection Pole at the Polonnaruwa Observation Station
Installed an Additional Lightning Protection Pole at the Ratnapura Observation Station
Before Construction (November 2009 – February 2015)
After Construction (February 2015 – November 2016)
Frequency of damage caused by lightning at these stations
9 times
NONE
Construction of an Additional Lightning Protection Pole


Traveling Standard
Portable Automatic Weather Observation Systems Operation Manual
"Comparison & Inspection Manual of the AWSs with the Portable Observation Data Comparison & Maintenance Tool"
Total Number
Training
Participant
12
63
Training for Portable Observation Data Comparison & Maintenance Tool


Cleaning/Maintenance Procedure For Automatic Weather Station
Electronic Engineering Division
Department of Meteorology
Sri Lanka
2016
Training on Automatic Weather Station (AWS) Cleaning/Inspection for Observation Station
Revision of the "Automatic Weather Station (AWS) Cleaning/Inspection User Guide for Observation Station" and "AWS Cleaning/Inspection Report"
Total Number
Training
Participant
2
11
*Additional Training will be conducted during the Officer In Charge Meeting in 2017

Output [2]

Communication

Activities

- Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. — JICA Team with the help of DOM
- Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.
- Review the current situation on GTS/MSS, and identify the issues to be improved.
- Replace and upgrade the GTS/MSS — JICA TEAM & DOM STAFF

Output [3]

Forecast in Different Scales

Activities

- Review the current situation on weather forecasting and identify the issues to be improved. — JICA Team with the help of DOM
- Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification.
- Prepare weather guidance products for rainfall for short range (4 stations: Colombo, Ratnapura, Potuvil and Puttalam), weekly and seasonal (2 stations: Colombo and Ratnapura) at the selected stations. — JICA TEAM & DOM STAFF
- Produce weather forecast guidance of sea wind at the selected stations.
- Verify and improve the existing methods of seasonal forecast.
- Conduct on-the-job training on improvement of weather forecasting operation through integration of various data.
- Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). — DOM with the help of JICA Team

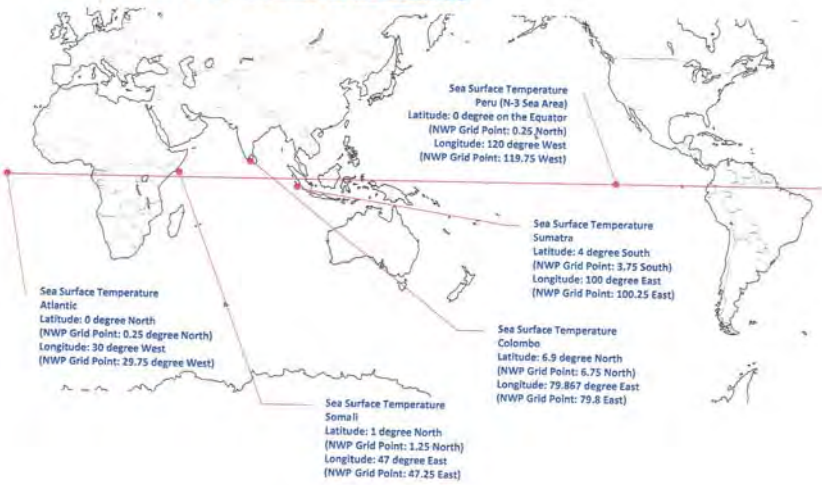
Results

Colombo

Short Range Rainfall Forecast	12h	24h	36h
First Intermonsoon	0.57	0.62	0.42
Southwest Monsoon	0.90	0.43	0.54
Second Intermonsoon	0.66	0.69	0.62
Northeast Monsoon	0.52	0.59	0.52

(Multiple Regression)

Location of SST for Seasonal Forecast Guidance



Output [4]

Early Warnings

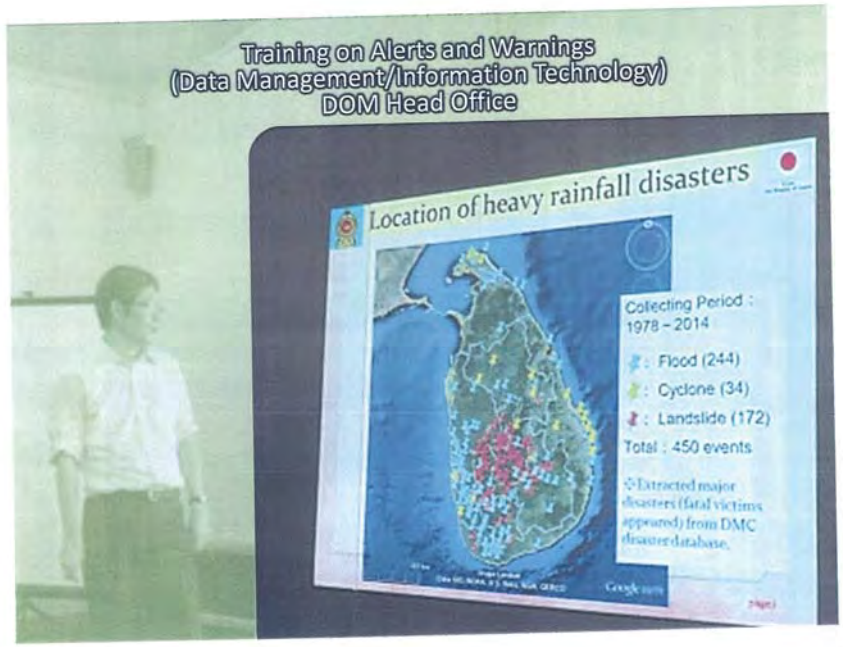
Activities

- Review the current situation on warnings, and identify the areas to be improved.

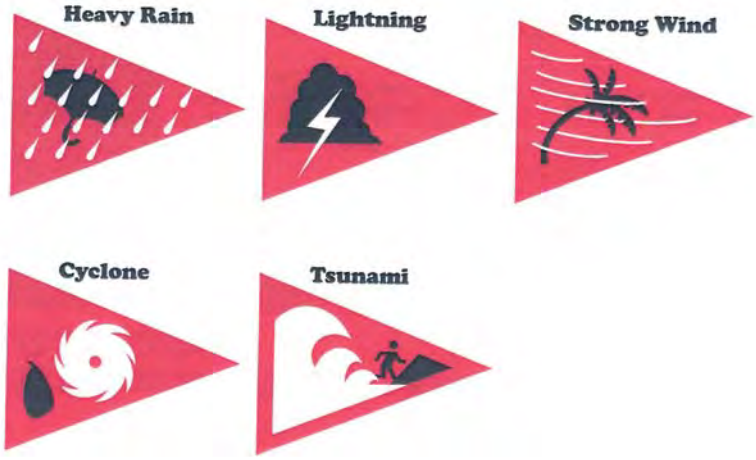
JICA Team with the help of DOM

- Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning

JICA TEAM & DOM STAFF



DOM Warning Symbols

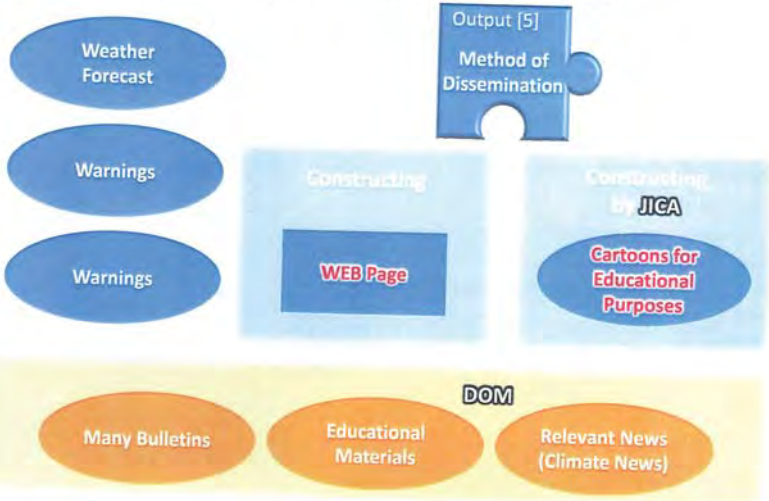


Improvement of Warning Criteria (Heavy Rain)

Climatic Zone	Option1 Criteria (Disaster Event Analysis)	Option2 Criteria (Statistical Analysis)	Geographical Area	Option3 Criteria (Statistical Analysis)
Wet Zone + Intermediate Zone	Advisory R > 50mm/6h & R > 90mm/24h	Advisory R > 45mm/24h	Mountain Area	Advisory R > 35mm/24h
	Warning R > 120mm/24h	Warning R > 85mm/24h		Warning R > 65mm/24h
Dry Zone	Advisory R > 50mm/6h & R > 70 mm/24h	Advisory R > 55mm/24h	Plain Area	Advisory R > 50mm/24h
	Warning R > 100mm/24h	Warning R > 100mm/24h		Warning R > 100mm/24h

Overall Goal

Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.



Output [5]

Dissemination

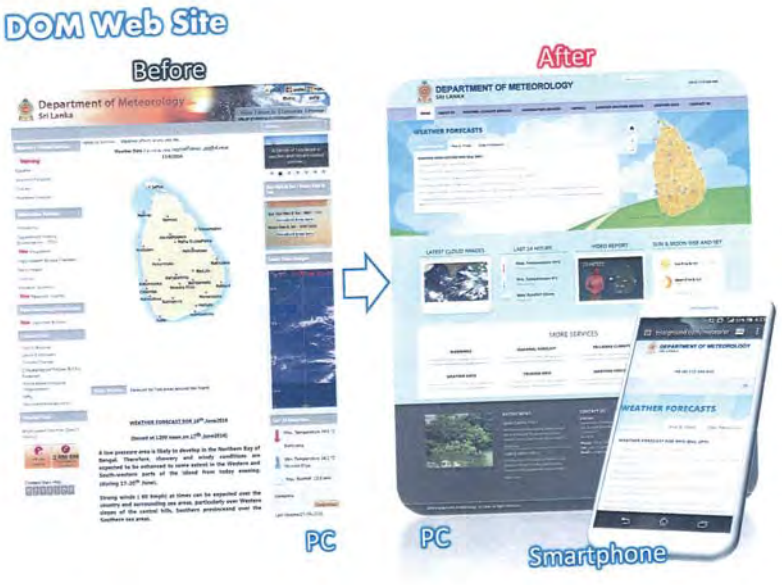
Activities

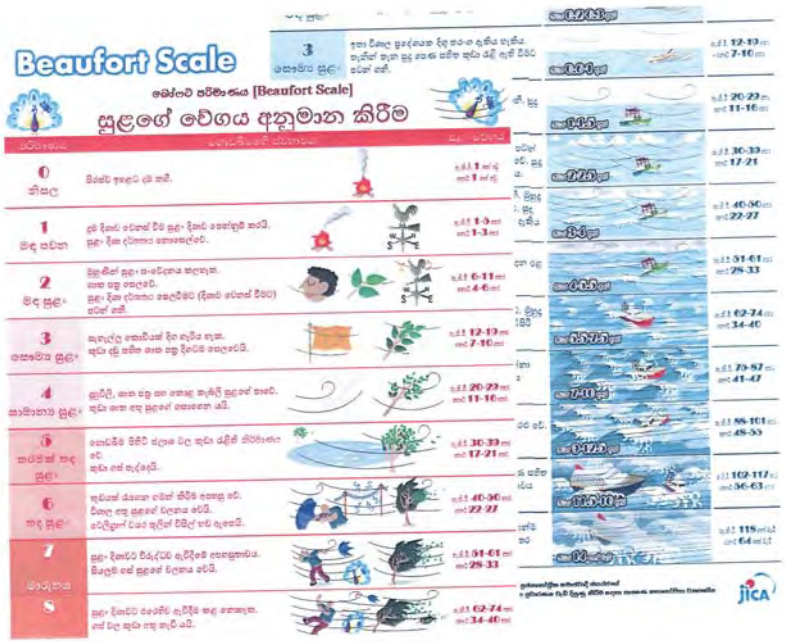
- Review the contents of current meteorological information and identify the issues to be improved.

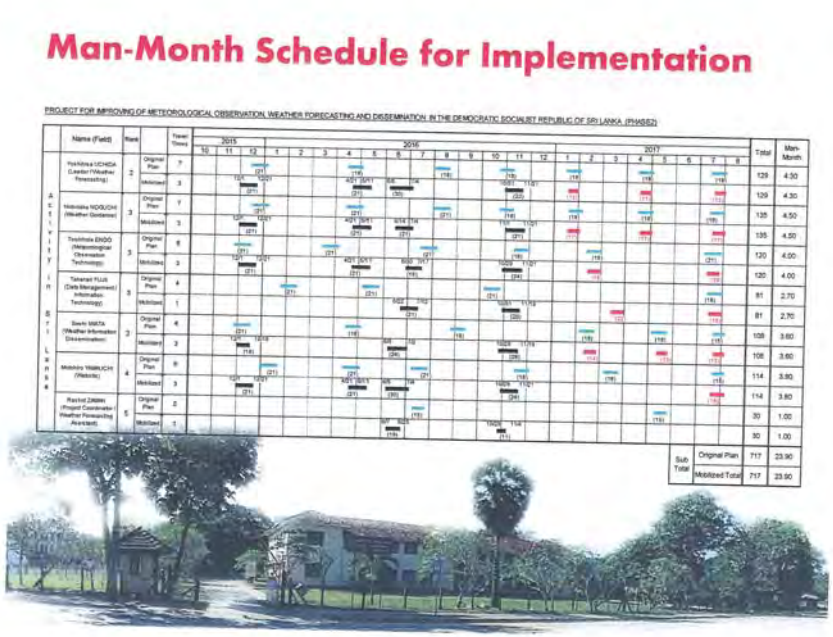
JICA Team with the help of DOM

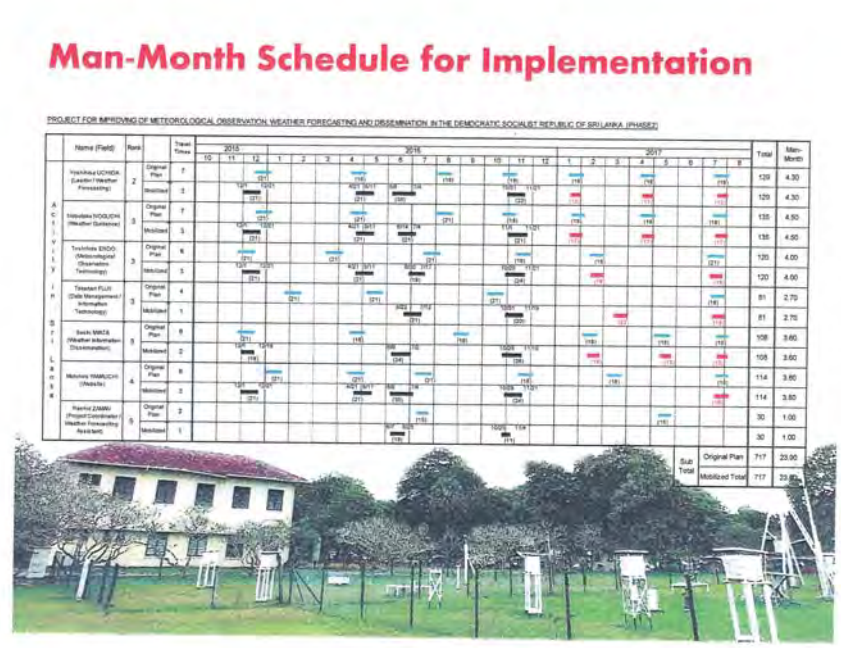
- Improve the contents of meteorological information.
- Review the timing of information dissemination to ships and fleet.
- Improve the contents of Website.
- Prepare smartphone compatible website
- Prepare educational materials (disaster awareness materials) for the weather services.

JICA TEAM & DOM STAFF




Beaufort Scale
මෙස්පට් පරිමාණය [Beaufort Scale]
සුළඟේ වේගය අනුමාන කිරීම
0 නිසඳ
1 මඳ සඩන
2 මඳ සුළං
3 මධ්‍යම සුළං
4 සාමාන්‍ය සුළං
5 තරමක් තද සුළං
6 තද සුළං
7 මාරුතය
8
JICA


Man-Month Schedule for Implementation
PROJECT FOR IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE2)
ACTIVITY IN SRI LANKA


Man-Month Schedule for Implementation
PROJECT FOR IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE2)
ACTIVITY IN SRI LANKA

Activities of Long-term Expert
During 2014 to 2016

1. Total Advising for the Project
2. Establishment of the Traceability of Meteorological Instruments
3. Reviewing the Upper-air Observation Schedule
4. Training Courses in Japan and Training Programs by Short-term Experts in DOM
5. Lecture on Meteorology
6. Others

Annex 3

2
Establishment of the Traceability of Meteorological Instruments

Activities of Long-term Expert
During 2014 to 2016
in
JICA-DOM Joint Technical Cooperation Project for
"Improving of Meteorological Observation,
Weather Forecasting and Dissemination in Sri Lanka"

Second Joint Coordination Committee
18 November 2016

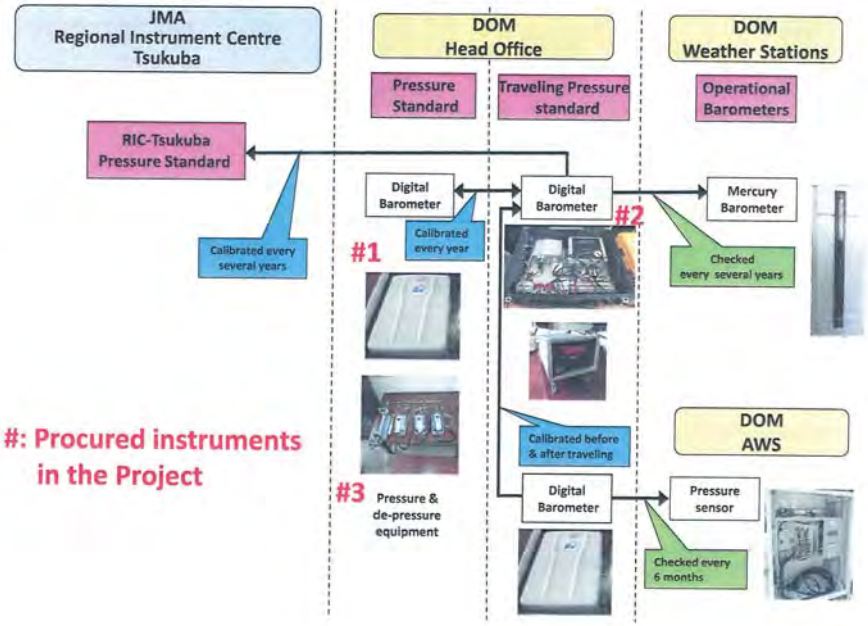
Masahito Ishihara
Project Chief Advisor
JICA Long-term Expert

● Time Table for New Calibration System

	2014				2015												2016												2017								
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Planning																																					
Procurement of Instruments																	1-st Procurement												2-nd Procurement								
Installation																																					
Calibration at RIC-Tsukuba																																					
Training in Japan																																					
Short-term Expert from JMA																																					
Actions by DOM staff																																					

1-st Installation
2-nd Installation
Calibration of Digital Barometer
2-weeks Training Course at RIC-Tsukuba
Training at DOM
Evaluation at DOM
Preparation
start of new calibration system

● Improved Pressure Calibration Flow



● Preparation of New Instrument Calibration System

Training Course in Japan, February 2016

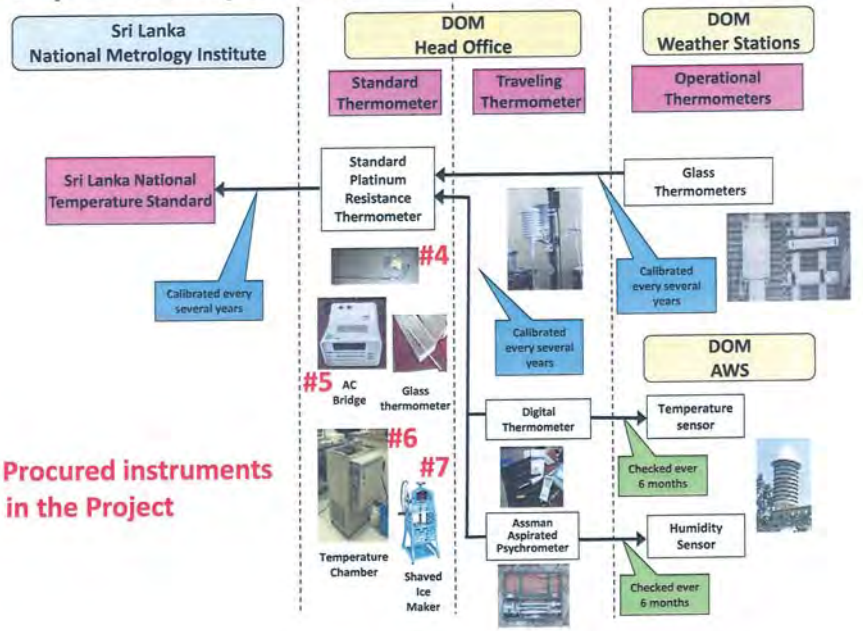
DOM Continuous Education and Training Program at Bandarawela, August 2016

Renovation of the calibration room

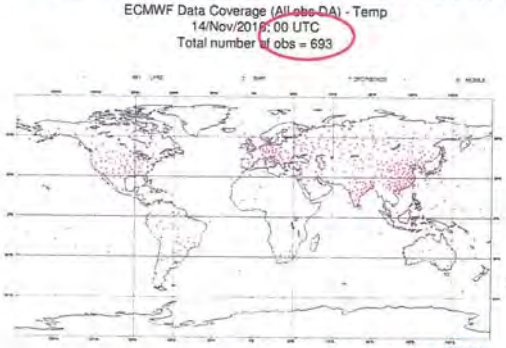
Draft of the rule of inspection of meteorological instruments

(General provision)
Article 1
This rule defines the inspection of the meteorological instruments (hereinafter referred to as "instruments") in Sri Lanka Department of Meteorology (hereinafter referred to as "DOM"). The inspection is hereinafter referred to as "instrument inspection".

● Improved Temperature/Humidity Calibration Flow



- Radiosonde Observation sites in the world (00 & 06 UTC)



06 UTC observation of DOM belongs to the minor group in the world

Table 1. Radiosonde observations being made in the neighboring countries around Sri Lanka. According to the WMO report (http://cap-ntcr.mipt.ru/all_doc/c4/index.htm),

India	32 stations	every day, 00UTC + 12UTC
Bangladesh	3 stations	every day, 00UTC + 12UTC
Maldives	1 station	every day, 12 UTC
Pakistan	1 station	every day, 00UTC + 12UTC
Thailand	5 stations	every day, 00UTC + 12UTC
Indonesia	13 stations	every day, 00UTC + 12UTC
Malaysia	8 stations	every day, 00UTC + 12UTC
Myanmar	No report	

http://www.ecmwf.int/en/forecasts/charts/monitoring/dcover?time=2016111400,0,2016111400&obs=Temp

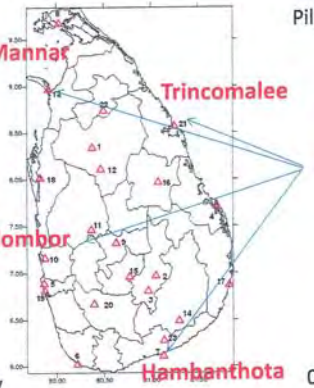
3
Reviewing the Upper-air Observation Schedule

Activities of Long-term Expert During 2014 to 2016

1. Total Advising for the Project
2. Establishment of the Traceability of Meteorological Instruments
3. Reviewing the Upper-air Observation Schedule
4. Training Courses in Japan and Training Programs by Short-term Experts in DOM
5. Lecture on Meteorology
6. Others

- Current situation of upper-air observation at DOM

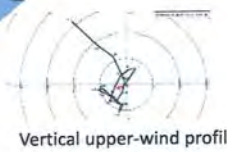
Radiosonde Observation



Pilot Balloon Observation

06 UTC
on Monday, Wednesday and Friday

Thermodynamic chart

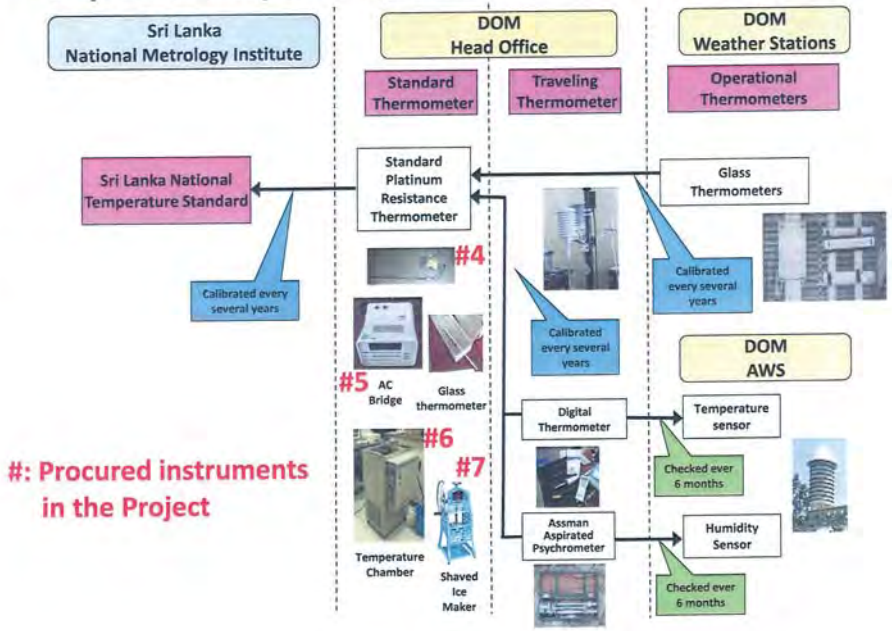


Vertical upper-wind profile

00, 06, 12 UTC every day

Time-height cross section of upper-winds at 4 stations

● Improved Temperature/Humidity Calibration Flow



2

Establishment of the Traceability of Meteorological Instruments

● Time Table for New Calibration System

	2014	2015	2016	2017
	9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9
Planning	■			
Procurement of Instruments		■ 1-st Procurement	■ 2-nd Procurement	
Installation		■ 1-st Installation	■ 2-nd Installation	
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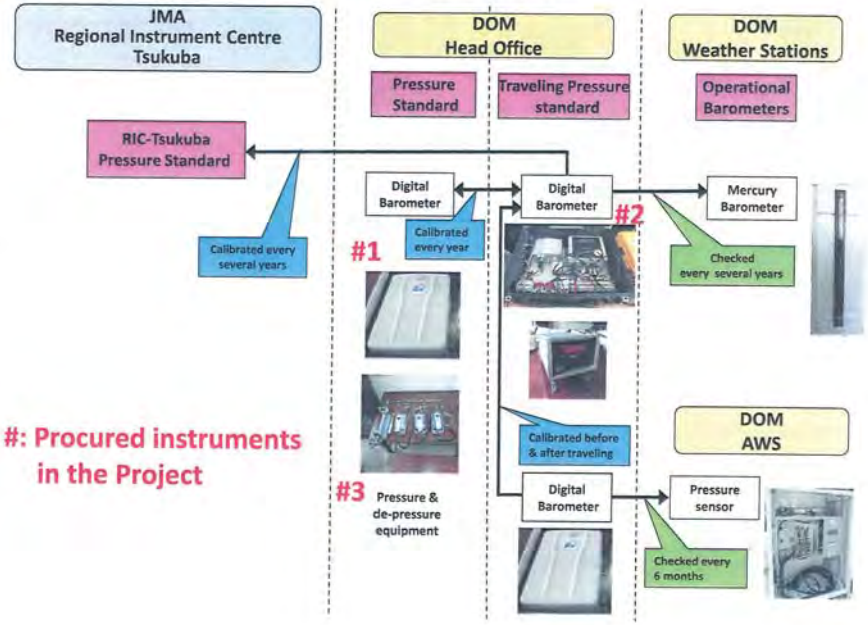
Short-term Expert from JMA			■ Training at DOM ■ Evaluation at DOM	
Actions by DOM staff			■ Preparation → start of new calibration system	

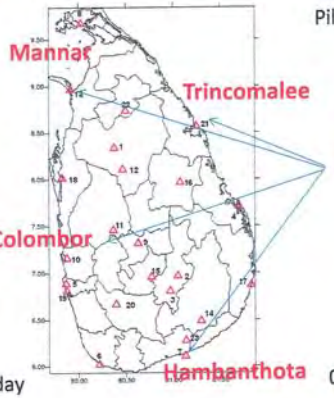
● Improved Pressure Calibration Flow



Current situation of upper-air observation at DOM

Radiosonde Observation

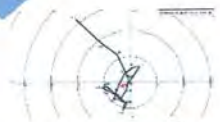
06 UTC
on Monday, Wednesday and Friday



Pilot Balloon Observation

00, 06, 12 UTC every day

Thermodynamic chart



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Time-height cross section of upper-winds at 4 stations

Preparation of New Instrument Calibration System

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(General provision)
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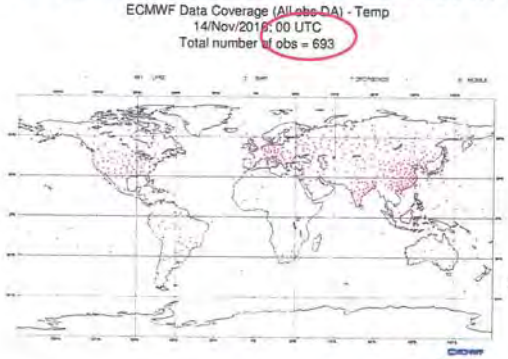

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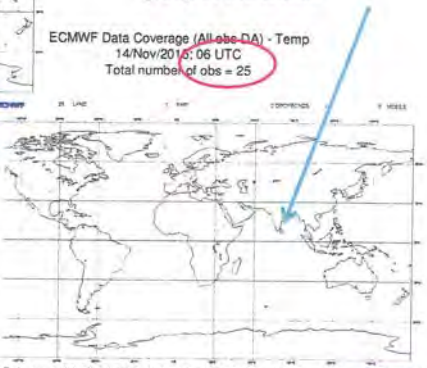

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Myanmar	No report	

http://www.ecmwf.int/en/forecasts/charts/monitoring/dcover?time=2016111400,0,2016111400&obs=Temp

3
Reviewing the Upper-air Observation Schedule

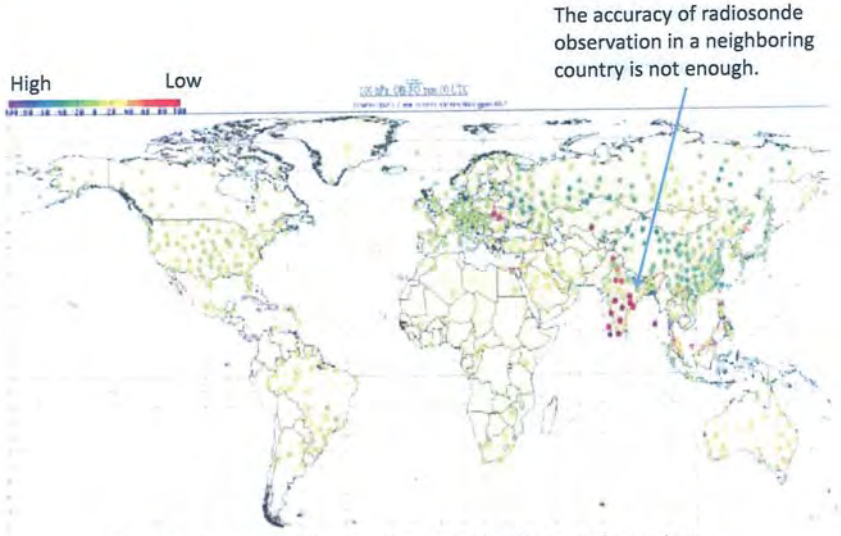
Recommendations

- The schedule of the radiosonde observations of DOM, three times per week, should be shifted to daily observation.
  Until the daily observation through a year will be established, daily operation should be made during two inter-monsoon seasons, when risk of heavy rainfall is higher than in the Monsoon seasons.

- Although DOM radiosonde observation time (06 UTC) is not much to the WMO standard time (00 UTC, 12 UTC), the current observation data are appropriately utilized in the forecast services of DOM.
  Radiosonde observation at 00 UTC and 12 UTC, should be considered in the middle-term operation plan of DOM to coincide with the WMO standards.

- The existing pilot-balloon observations should be continued in order to monitor the mesoscale circulation over Sri Lanka.
  Installation of a wind profile network system should be discussed in the long-term plan of DOM.

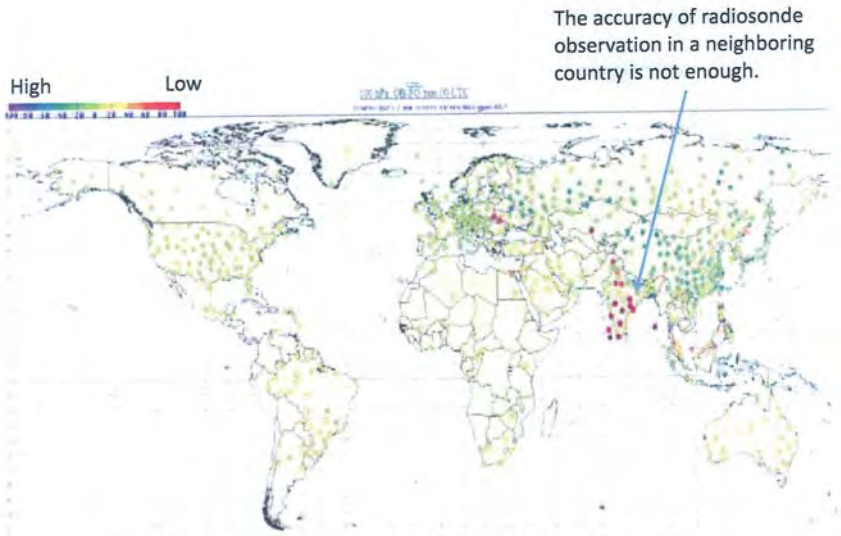
Accuracy of Radiosonde Observation in the world (00 UTC)



http://cao-ntcr.mipt.ru/all_doc/c4/ecmwstn/2015/2015-4obfgzmap.htm

4
Training Courses in Japan and Training Programs by Short-term Experts in DOM

Accuracy of Radiosonde Observation in the world (00 UTC)



http://cao-ntcr.mipt.ru/all_doc/c4/ecmwstn/2015/2015-4obfgzmap.htm

Planned Training Courses by Short-term Experts

- **Theoretical Meteorology in the Tropics**:
  21 November to 2 December, 2016
  Manabu YAMANAKA, PhD
  Senior Researcher, Professor Emeritus of Kobe University, Japan
  Maritime Continent Climate Team
  Japanese Agency Marine-Earth Science and Technology (JAMSTEC)

- **Operational Meteorology in the Tropics**:
  23 to 27 January, 2017
  Atsushi GOTO, MSc
  Scientific Officer
  Tokyo Climate Center, Climate Prediction Division
  Global Environment and Marine Department, Japan Meteorological Agency

- **Weather Analysis in the Tropics using SATAID**:
  April, 2017
  After the installation of the Himawari-cast system at DOM by JICA

Training Courses in Japan (Instrument Calibration)

8 to 19 February 2016, Tsukuba and Tokyo, 4 DOM staff

Planned Training Courses by Short-term Experts (cont.)

- **Instrument Calibration I**: 13 to 20 January, 2017
  Sadanori Arakaki, Msc
  Satoshi Hagiya
  WMO Regional Calibration Center, Japan Meteorological Agency
- **Instrument Calibration II**: July or August, 2017
  Details are not decided.

Planned Training Courses in Japan

- **Weather Forecasting II** : February to March , 2017
  Details are being arranged by the JICA Consultant Team.
- **Meteorological Observations**: 13 to 24 February, 2017
  Modernization of meteorological observations

Training Courses in Japan (Weather Forecasting)

29 February to 15 March, 2016
Gifu University and Tokyo
Organized by the JICA Consultant Team
4 DOM staff

6 Others

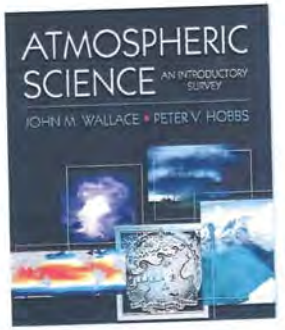
- Participating in the surveys of landslide sites conducted by Mr. Handa of the JICA-NBRO Project: Koslanda 2014, Kotmale 2015 and Aranayake 2016.
- Suggesting basic planning of the JICA Project for the Establishment of a Doppler Weather Radar Network in Sri Lanka.
- Coordinating the short-term research visits to the Disaster Prevention Institute of Kyoto University.
- Visiting the DOM weather stations in order to examine the current situation of the surface observation in Sri Lanka.

5
Lecture on Meteorology

Lecture on Meteorology

January 2015 to August 2016
Lecturer: Masahito Ishihara
Assistant: Thakshila Gamage

1 Introduction and Overview
2 The Earth System
3 Atmospheric Thermodynamics
4 Radiative Transfer
6 Cloud Microphysics
7 Atmospheric Dynamics
8 Weather Systems



Minutes of Meeting for the 3rd Joint Coordinating Committees (JCCs)

MINUTES OF THE MEETING
OF THE
JOINT COORDINATION COMMITTEE (JCC)
ON THE
TECHNICAL COOPERATION PROJECT
FOR THE
IMPROVING OF THE METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

The series of discussions on the above captioned project among the concerned officials of the Government of Sri Lanka and Japan International Cooperation Agency (JICA) Sri Lanka Office have been conducted under the chairmanship of Mr. S. S. Miyanawala, Secretary of the Ministry of Disaster Management. As the result of the discussions, both sides have confirmed the main items described in the attached sheet.

Colombo, May 02, 2017

Fusato Tanaka
Chief Representative
Japan International Cooperation Agency
JICA Sri Lanka Office

Lalith Chandrapala
Director General
Department of Meteorology (DOM)

ATTACHMENT

1. Project Name

Technical Cooperation Project for the Improving of the Meteorological Observation, Weather Forecasting and Dissemination in the Democratic Socialist Republic of Sri Lanka

2. Implementing Agency

Ministry of Disaster Management, Department of Meteorology (DOM), Sri Lanka and Japan International Cooperation Agency (JICA)

3. Summary on the Achievements of the Activities of the Project

An introduction of the summary on the Achievements of the Activities of the Project was made by the Director General of the DOM and the DOM mentioned that it is expected that all the Achievements indicated in the Project Design Matrix (PDM) will be satisfied by the completion of the Project. Especially, the DOM mentioned that the re-tender for the selection of the IP-VPN service provider was already completed last March for the transition from the current VSAT system to the IP-VPN system.

4. Introduction of the Current Progress and Issues of each Activity and Achievement of Output by the JICA consultant team as well as the Achievement of the Project Purpose in the PDM as of April 2017

After the introduction delivered by the DOM, the JICA consultant team made the Introduction of the Current Progress and Issues of each Activity and Achievement of Output as well as the Achievement of the Project Purpose in the PDM as of April 2017.

5. Explanation of the Significant Issues for the Successful Completion of the Project

The JICA consultant team explained the following significant issues for the successful completion of the Project.

- Training on the operation of the Global Telecommunication System Message Switch procured under the Project.
- Transition from the current VSAT system to the IP-VPN system.

The JICA consultant team mentioned that the last training on the operation of the Global Telecommunication System Message Switch just started today for 5 days which will be completed by May 06, 2017. In addition, the JICA consultant team requested the DOM to

complete the transition from the current VSAT system to the IP-VPN system as soon as possible. The DOM indicated that the contract procedures are in progress and agreed to complete the transition quickly.

6. Introduction of the Current Progress of each Activity of the JICA long term expert as of April 2017

The JICA long term expert made the Introduction of the Current Progress of each Activity in his scope as of April 2017.

7. Presentation of the JICA Counterpart Trainings in Japan in 2017

After the Introduction of the Current Progress of each Activity in his scope by the JICA long term expert, he continued to make the Presentation of the JICA Counterpart Trainings in Japan in 2017.

8. Presentation of the Further Activities of the JICA long term expert and the Consultant experts by the end of the Project

The JICA long term expert and the Consultant experts presented the Further Activities that will be conducted by the end of the Project.

9. Explanation of the Prospective Recommendations for the Overall Goal of the Project

The JICA long term expert explained that the Prospective Recommendations delivered to each attendee is just the draft and that it would be finalized soon.

10. The Secretary of the Ministry of Disaster Management and the Director General of the Department of Meteorology expressed their appreciation to all the attendees of the JCC.

Annex 1: List of Attendants of JCC
Annex 2: Project Achievement
Annex 3: Important issues for the successful completion of the Project
Annex 4: Further Activities of the JICA Consultant Experts Team
Annex 5: Activities of JICA Long Term Expert
Annex 6: Planning up to the completion of the project
Annex 7: Prospective Recommendations (Draft)

Annex-1

LIST OF ATTENDANTS

JOINT COORDINATION COMMITTEE (JCC)
FOR
TECHNICAL COOPERATION PROJECT
FOR
IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Location: Conference Room, Ministry of Disaster Management
Time: ~~10:00~~ 14:00, May 02, 2017

No.	Name	Position	Signature
1	S.S. Miyanawala	Sec / MDM	
2	Lalith Chandrapala	DG / DOM	
3	K H M S Premalal	Director (DOM)	
4	Masahito Ishihara	JICA Long-term Expert	
5	Yoshihisa UCHIDA	JICA Consultant Expert Team	
6	Nobutaka NOGUCHI	JICA Consultant Team	
7	Toshihide ENDO	JICA Consultant Team	
8			
9			
10			

Project Achievement

Project Purpose	Indicators	Achievements of Project Purpose
Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Traceability of meteorology instruments (Availability of national standards/frequency of inspection)	In addition to the completion of the planned establishment of the traceability of the meteorological instruments for temperature and atmospheric pressure, the traceability of the meteorological instruments for humidity and wind speed were also partly established which was not part of the original plan.
	2. Number of missing observation data	The transition from the current VSAT system to the IP-VPN system is planned to be implemented from May to June 2017. Once done, the number of missing observation data will be confirmed.
	3. Accuracy of rainfall forecast in the selected stations.	▪ Preparations for the increase in the accuracy of rainfall forecast have been completed after the completion of rainfall forecast guidance 12, 24 and 36 hours ahead at 2 points (Colombo and Ratnapura) using the Grid Point Value of DOM's numerical prediction model (WRF). ▪ Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours precipitation) Weather Forecast Guidance with the WRF Grid Point Vale has been operating for the increase in the accuracy of rainfall forecast of Colombo.
	4. Number of selected station where weekly forecast is enabled in trial basis.	Colombo and Ratnapura: Weekly forecasts guidance was conducted from January to July 2017 on a trial basis using Model Output Statistics (MOS) with the GFS numerical prediction model of the NOAA.

Output	Indicators	Achievement of Output
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	1-1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project.	100% The Cleaning/Maintenance Procedure for the AWS, Preventive Maintenance Record Book for the AWS and the Spare Parts Replacement Procedure for the AWS have been revised.
	1-2 Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff.	100% 29 engineers, technicians and officers (81% of the total relevant DOM staff) have participated in the training sessions.

Activities	Activities Ratio (%)	Achievements of Activities
1-1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved.	100%	Through several discussions with the DOM and the results of the Baseline Study, the identification of the current issues to be improved by the Project has been done.

	1-2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration	100%	Procurement of all the planned equipment has been completed.
	1-3 Establish the traceability of meteorological instruments.	75%	Activity of the JICA Long Term Expert ▪ The traceability of pressure and temperature has been established. ▪ An Instrument Calibration Laboratory has been established in the DOM in January 2017. ▪ Rules, guidelines and manuals to maintain the traceability will be completed by June 2017.
	1-4 Conduct training on calibration of conventional and AWS equipment.	75%	Activity of the Short Term Expert to be arranged by JICA ▪ The training on instrument calibration by the Short Term Experts from the JMA was conducted at the DOM in January 2017. ▪ The second training on instrument calibration by the Short Term Experts from the JMA is scheduled to be conducted at the DOM in June 2017 to evaluate the achievement of the new calibration method.
	1-5 Review and revise the Standard Operation Procedure for manual and AWS observations	100%	▪ Preparation of the "Comparison & Inspection Manual of the AWSs with the Portable Observation Data Comparison & Maintenance Tool (Portable AWS Operation Manual)" has been completed. ▪ Revision of the "Observation Manual" for manual observation has been completed.
	1-6 Review and revise inspection and repairing (parts replacing) user's guide for AWS.	100%	▪ Revision of the "Automatic Weather Station (AWS) Cleaning/Inspection User Guide for Observation Station" and "AWS Cleaning/Inspection Report for Observation Station" has been completed. ▪ Revision of the "Regular Inspection Book (AWS Periodic Inspection Manual)" and preparation of the "Calibration Manual of the Meteorological Observation Instruments with the Standard Instruments" and "User Guide for AWS Failure Recovery" (replacement of spare parts) has been completed.
	1-7 Conduct training on inspection and repairing of AWS	100%	▪ Construction of an additional lightning protection pole which is needed at three particular sites (Ratnapura, Polonnaruwa, and Aralagatonwila) vulnerable to lightning strikes have been conducted through practical trainings. ▪ The training in accordance with the "Automatic

			Weather Station (AWS) Cleaning/Inspection User Guide for Observation Station" and "Comparison & Inspection Manual of the AWSs with the Portable Observation Data Comparison & Maintenance Tool (Portable AWS Operation Manual)" have been conducted. ▪ The trainings in accordance with the "Regular Inspection Book (AWS Periodic Inspection Manual)," "Calibration Manual of the Meteorological Observation Instruments with the Standard Instruments" and "User Guide for AWS Failure Recovery" (replacement of spare parts) has been completed. ▪ The training on Automatic Weather Station (AWS) Maintenance conducted after the Seminar for all the officer in-charges of the Regional Meteorological Offices has been completed.
	1-8 Review the upper air observation schedule.	75%	Activity of the JICA Long Term Expert ▪ The report to revise the upper air observation schedule was completed. In the report prepared, the daily implementation of radiosonde observation in Colombo is highly recommended. ▪ A Short Term Expert on upper air observation from the JMA will visit the DOM in June 2017 to evaluate the report and to provide additional support to strengthen the upper air observation capacity of the DOM.

Output	Indicators	Achievement of Output
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	2-1 Data from AWS are obtained and made available to a full extent in DOM.	80% The transition from the current VSAT system to the IP-VPN system is planned to be implemented from May to June 2017. Once done, the indicators will be confirmed.
	2-2 Binary data via. GTS are obtained and made available to a full extent in DOM during the Project.	100% Binary data from the India Meteorological Department have been obtained. Additional Trainings for GTS operation have been started from May 2, 2017.

Activities	Activities Ratio (%)	Achievements of Activities
2-1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved.	100%	Through several discussions with the DOM and the Baseline Study, the current issues to be improved upon have been identified. The current situation on transmitting and receiving observed data between the AWS sites and the headquarters of the DOM has been reviewed by the DOM and the Team together.

	2-2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.	80%	▪ The trial test on the possible backup means (IP-VPN utilizing a ground communication network) for the transmission and receipt of observation data in order to observe weather phenomena on a real-time basis has been successfully completed. ▪ The diagram of the before and after scenario on the change of the system network which utilized the IP-VPN has been prepared and presented. ▪ A flowchart has been prepared for the smooth transition from the current VSAT system to the IP-VPN system. ▪ Re-tender for selection of the IP-VPN service provider will be conducted by the DOM in May 2017. ▪ The transition from the current VSAT system to the IP-VPN system is planned to be implemented from May to June 2017.
	2-3 Review the current situation on GTS/MSS, and identify the issues to be improved.	100%	Through several discussions with the DOM and the Baseline Study, identification of the current issues to be improved upon has been completed.
	2-4 Replace and upgrade the GTS/MSS.	100%	Procurement of all the required GTS/MSS equipment for replacement with the existing one by the JICA Head Office and installation and necessary operation & maintenance training at the DOM Head Office by the equipment supplier's engineers have been completed.

Output	Indicators	Achievement of Output
3. Capacity of weather forecasting is improved using obtained meteorological data.	3-1 At least 4 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance.	100% 15 Forecasters can produce the short range and weekly weather forecast guidance.
	3-2 At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind.	100% 15 Forecasters can produce the weather forecast guidance of sea wind.

Activities	Activities Ratio (%)	Achievements of Activities
3-1 Review the current situation on weather forecasting and identify the issues to be improved.	100%	Through several discussions with the DOM and the results of the Baseline Study, the identification of the current issues in weather forecasting which is in transition from a qualitative forecast to a quantitative forecast has been completed.
3-2 Conduct the training on the development of short range (every 12 hours	100%	The required trainings for development and verification of; 1) Short Range (Colombo and Ratnapura: every 12 hours precipitation up to 36 hours ahead)

	precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification.		Weather Forecast Guidance. 2) Short Range (Pothuvil and Puttalam; 24 hours and 48 hours ahead) Sea Wind Weather Guidance, and, 3) Weekly (168h) Rain Weather Guidance (Colombo and Ratnapura), have been completed.
	3-3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations.	100%	Collections of the Grid Point Value of: 1) Regional NWP Model (WRF) of Sri Lanka and the observation data of the AWSs for the production of short range weather forecast guidance; and, 2) GFS (NOAA Global Forecast System) for the production of weekly (7 days ahead) weather forecast guidance have been completed. Productions of: 1) Short Range (Colombo and Ratnapura: every 12 hours precipitation up to 36 hours ahead) Weather Forecast Guidance (Colombo Rain, Ratnapura Rain and Colombo Mesh Rain) with the WRF Grid Point Vale; 2) Short Range (Pothuvil and Puttalam; 24 hours and 48 hours ahead) Sea Wind Weather Guidance with the WRF Grid Point Vale; 3) Weekly (168h) Rain Weather Guidance (Colombo and Ratnapura) with the GFS (NOAA Global Forecast System) Grid Point Vale of 0.5 and 0.25 degree mesh data; and, 4) Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours precipitation) Weather Forecast Guidance with the WRF Grid Point Vale have been completed.
	3-4 Produce weather forecast guidance of sea wind at the selected stations.	100%	Collection of the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka and the observation data of the AWSs for production of forecast guidance has been completed.
	3-5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID).	75%	Activity of the Short Team Expert to be arranged by JICA. ■ A lecture on Basic Meteorology was conducted by the JICA Long Term Expert. ■ Two types of training on theoretical and operational tropical meteorology were conducted by JICA Short Term Experts in December 2016 and January 2017 under the guidance of the JICA Long Term Expert. ■ The Himawari Cast Receiver and SATAID will be installed at the DOM in June 2017 by JICA HQ. ■ SATAID training will be conducted after the

			installation of the Himawari Cast Receiver in June 2017.
	3-6 Verify and improve the existing methods of seasonal forecast.	100%	Development and verification of seasonal weather forecast guidance (by 2040) with sea surface temperature observation data at 5 selected points in Pacific, Indian and Atlantic Oceans and rainfall observation data of Colombo for 36 years with the CFS (NOAA Climate Forecast System) Grid Point Vale have been completed.
	3-7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data.	100%	■ Installation trainings of VMware, Linux (CentOS) and Wgrib2 have been completed. ■ Trainings for downloading reanalysis data and extraction of the required CSV data and other products from grib2 data of the global meteorological organizations (NOAA Climate Forecast System, etc.) which is useful for NWP model operation have been completed. ■ Trainings for preparation of attractive forecast products with Power Point have been completed.

Output	Indicators		Achievement of Output
4. Warning criteria is elaborated.	4-1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared.	100%	■ Warning/advisory criteria of heavy rain: 2 climatic zones (Wet Zone and Intermediate Zone / Dry Zone) and 2 geographical zones (Plain Area / Mountain Area) ■ Warning/advisory criteria of strong wind: 1 area (whole country) ■ Advisory criteria of lightning: 2 climatic zones (Wet Zone and Intermediate Zone / Dry Zone)
	Activities	**Activities Ratio (%)**	**Achievements of Activities**
	4-1 Review the current situation on warnings, and identify the areas to be improved.	100%	Through several discussions with the DOM and the results of the Baseline Study, the identification of the current issues has been completed.
	4-2 Review the current situation on warnings, and identify the areas to be improved.	90%	■ Warning/Advisory signs for heavy rain, strong wind, lightning, cyclone and tsunami have been improved which follows "Universal Design". ■ Warning/advisory criteria of heavy rain have been newly set in 2 climatic zones (Wet Zone and Intermediate Zone/Dry Zone) and 2 geographical zones (Plain Area/Mountain Area) through several discussions with DOM. ■ Warning/advisory criteria of strong wind have been newly set in whole country through several discussions with DOM. ■ Advisory criteria of lightning have been newly

			set in 2 climatic zones (Wet Zone and Intermediate Zone/Dry Zone) through several discussions with DOM. ■ To conduct internal operation and validation of the new Warning/Advisory criteria for Heavy Rain & Strong Wind and also the new Advisory criteria for Lightning with the Duty Forecasters.

Output	Indicators		Achievement of Output
5. The method of dissemination and contents of meteorological information are improved.	5-1 Number of developed educational material for weather services.	100%	■ DOM mascot for disaster awareness ■ Disaster Awareness Cartoons for Disaster Prevention Education 1) Climate of Sri Lanka (English, Sinhala and Tamil) 2) Thunderstorm and Lightning (English, Sinhala and Tamil) 3) Heavy Rain and Disaster (English, Sinhala and Tamil) ■ DOM Beaufort Scale 1) Land (English, Sinhala and Tamil) 2) Sea (English, Sinhala and Tamil) Total: 6 materials
	5-2 Monthly access number of the DOM Website is increased by 30% or more.		Currently being monitored
	Activities	**Activities Ratio (%)**	**Achievements of Activities**
	5-1 Review the contents of current meteorological information and identify the issues to be improved.	100%	Through several discussions with the DOM and the results of the Baseline Study, the identification of the areas to be improved upon has been completed.
	5-2. Improve the contents of meteorological information.	100%	Meteorological information for timely provision to the users has been improved and posted on the new DOM Web site.
	5-3. Review the timing of information dissemination to ships and fleet.	100%	Meteorological Information for ships and fleet for timely provision to the users have been posted on the new DOM Web site.
	5-4 Improve the contents of Website.	100%	1) Modification/optimization of the Website products prepared by the DOM suitable for any device of the stakeholders with Windows OS, Mac OS, iOS (iPhone, iPad) and Android; 2) Preparation of the external site named "Save Yourself" for displaying and downloading the animated cartoons by any access devices of the stakeholders; 3) Allocation a link banner on the front page of

			the new DOM Website which is connected with an external link of the animated cartoons; and, 4) Allocation of the meteorological satellite (Himawari-8) and radar pictures on the new DOM Website have been completed.
	5-5 Prepare smartphone compatible website	100%)	■ Design and development of the new DOM Website by Joomla 3.4, CMS (Contents Management System) which enables compatibility with any device(PC, smartphone, tablet, etc.) and easy website update have been completed. ■ The new Website programs have been submitted by the DOM to the ICTA (Information and Communication Technology Agency of Sri Lanka) for replacement of the existing DOM Website. ■ Replacement of the existing DOM Website with the new one by ICTA after the examinations in accordance with the technical regulation of ICTA has been completed.
	5-6 Prepare educational materials (disaster awareness materials) for the weather services.	100%	■ Design of the DOM mascot for disaster awareness has been made. ■ Production of 30,000 pieces of the DOM mascot made of rubber which is cadmium and formaldehyde free material for delivery to the school students has been completed. ■ Design of 5 characters in the cartoons has been completed. ■ Production of 3 episodes of disaster awareness cartoons (EP1: Climate of Sri Lanka, EP2: Thunderstorm and Lightning and EP3: Heavy Rain and Disaster) in English, Sinhala and Tamil have been completed (voice of 5 characters in the cartoons by DOM personnel) has been completed. ■ Production of the "DOM Beaufort Scale of Land and Sea" (English, Sinhala and Tamil) have been completed.

Important Issues
for the successful completion of the Project

1. Training on operation of the Global Telecommunication System Message Switch (Visual Weather, Moving Weather module of the Global Telecommunication System Message Switch, Access of WAFS data via the Secure SADIS FTP, BUFR Data Transmission) procured under the Project.

   <Training Schedule>
   09:00 - 16:30 between May 02, 2017 (Tuesday) and May 06, 2017 (Saturday) at the Head Office of DOM, Colombo

2. Re-tender for selection of the IP-VPN service provider by the DOM

3. Transition from the current VSAT system to the IP-VPN system (May to June 2017)

Further Activities of the JICA Consultant Expert Team

PDM Output	Further Activities of the Consultant Expert Team as of May 02, 2017
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	● To conduct an additional training to the staff of the Instrument Section who will be responsible for the cleaning/inspection work of the AWSs in the Collaborator Stations. ● To conduct an additional training on repairing (parts replacing) to the staff of the Engineering Section.
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	● To conduct the trainings on the Operation of the Global Telecommunication System Message Switch (Visual Weather and Moving Weather modules of the Global Telecommunication System Message Switch) supplied by the Contractor and Access to the WAFS data via the Secure SADIS FTP, BUFR Data Transmission between May 02, 2017 (Tuesday) and May 06, 2017 (Saturday). ● To support the DOM in the transition from a VSAT network to an IP-VPN for the Automatic Weather Observation Systems established under the previous project financed by Japan's Grant Aid.
3. Capacity of weather forecasting is improved using obtained meteorological data.	● To install the Semi-automatic Linux Program developed under the Project for Short Range (Colombo: every 12 and 24 hours precipitation) Weather Forecast Guidance with the WRF Grid Point Vale for operations. ● To monitor the performance of the installed Semi-automatic Linux Program. ● To continue Weekly forecasts guidance by July 2017 on a trial basis using Model Output Statistics (MOS) with the GFS numerical prediction model of the NOAA.
4. Warning criteria is elaborated.	● To conduct internal operation and validation of the new Warning/Advisory criteria for Heavy Rain with the Duty Forecasters. ● To conduct internal operation and validation of the new Warning/Advisory criteria for Strong Wind with the Duty Forecasters. ● To conduct internal operation and validation of the new Advisory criteria for Lightning with the Duty Forecasters.
5. The method of dissemination and contents of meteorological information are improved.	● To conduct additional Open Classes at four schools in the Nuwara Eliya district by using the animated cartoons "Save Yourself" prepared under the Project with the DOM counterparts. ● To conduct additional Open Classes at the DOM auditorium in the absence of the Japanese expert. ● To distribute additional DOM rubber mascots prepared under the Project to school children who participated in the Open Class. ● To distribute the additional laminated DOM Beaufort Scale (Land and Sea versions: English, Sinhala and Tamil) prepared under the Project to the stakeholders (school teachers, mass media, government organizations concerned with disaster management, military services, etc.). ● To conduct an additional lecture on drawing graphics using PowerPoint applying multiple animation effects.

1. Activities of the Long-term Expert
2. JICA Counter Part Trainings in Japan

3rd Joint Coordination Committee
Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination
2 May 2017

Activity 1.3
Establish the Traceability of Meteorological Instruments
(Long-term Expert)

Progress

- The traceability of pressure and temperature instruments is completely established.
- The traceability of humidity, wind and rainfall instruments is partially established.

Details

1. Instruments for calibration were procured, and trainings to handle them were made by the consultant team.
2. New Instrument Calibration room was constructed and opened in January 2017.
3. The training of instrument calibration were conducted as follows:
   a. JICA C/P training in JMA, two weeks, February 2016, with 4 DOM Staff
   b. JICA Short-term Expert training I at DOM, two weeks, January 2017, 14 DOM staff
4. Documents on instrument calibration has been prepared.
   a. Rule for the surface meteorological observations
   b. Guide for the inspection of meteorological instruments
   c. Manuals for inspection of barometer, thermometer and others)
5. Operation of the new instrument calibration has been started by DOM staff.

Issue and plan

- The traceability of humidity, wind and rainfall instruments should be completely established in the medium-term plan of DOM.
- JICA Short-term Expert training II in DOM, one week, June 2017 is scheduled.

Activity 1.6
Review the upper Air Observation
(Long-term Expert)

Pilot balloon observation

Radiosonde observation

Activity 1.3
Establish the Traceability of Meteorological Instruments
(Long-term Expert)

JICA C/P training in RIC-Tsukuba, JMA Feb. 2016

JICA Short-term Expert training I at DOM, Jan. 2017

Opening Ceremony of the DOM Calibration Laboratory on 16 Jan. 2017

Activity 3.5
Conducting Training on Satellite Animation and Interactive Diagnosis (SATAID)

Progress

- In advances of the SATAID training, three training courses for forecasters of DOM were implemented: Basics of meteorology, theoretical tropical meteorology and operational tropical meteorology.
- Installation of a HimawariCast (JMA Geostationary Weather Satellite Data Broadcasting System) receiving system with the SATAID Program at DOM was planned in JCA HQ and has been shipped out from Japan in mid April 2017.

Details

1. The training course on basics of meteorology "Lecture on Meteorology" was held by the JICA Long-term Expert during the period from January 2015 to August 2016 with the attendance of 18 trainees.
2. The training course on "Theoretical Tropical Meteorology" was given by Prof. Yamanaka of JAMSTEC during 21 November to 2 December 2016 with the attendance of 18 trainees.
3. The training course on "Operational Tropical Meteorology" was held by Mr. Goto of JMA during 23 to 27 January 2017 with the attendance of 23 trainees.

plan

- A HimawariCast receiver will be installed at DOM in late May 2017 as well as the interactive diagnosis software "SATAID".
- The SATAID training will be held by the short-term experts of JMA in late June 2017.

Activity 1.6
Review the upper Air Observation
(Long-term Expert)

Progress

- The review paper on the current upper-air observation was submitted to DG of DOM.

Details

1. The current situation of radiosonde observation was surveyed in Colombo.
2. The current situation of pilot balloon observation was surveyed at Polonnaruwa, Mannar and Colombo.
3. Analyses and evaluation were made, considering the usage of upper-air observation data in DOM and the other foreign countries.
4. The following recommendations are reported in the review paper.
   "The current schedule of the radiosonde observations of DOM: three times per week, should be shifted to daily observation."

plan

- A JICA short-term expert of upper-air observation will visit DOM in June 2017. He will make evaluation of the review paper made by the long-term expert and to make re-analysis of the situation of upper-air observation in DOM as well as making technical support to improve the current upper-air observation.

JICA Counter Part Trainings in Japan

Training Course on Meteorological Instrument Calibration

February 2016

Training Course on Weather forecasting and information dissemination I at Gifu Univ.

Training Course on Meteorological Observations

February 2017

Training Course on Weather Forecasting and Information Dissemination II at Gifu Univ. and Tsukuba Univ.

March 2017

Activity 3.5
Conducting Training on Satellite Animation and Interactive Diagnosis (SATAID)

Lecture on Meteorology (Jan. 2015- Aug.2016)

Theoretical Tropical Meteorology (Nov. 2016)

Operational Tropical Meteorology (Jan. 2017)

Installation of HimawariCast Receiver and SATAID training
(Coming May and June 2017)

Planning up to the completion of the project

MAY	JUNE	JULY	AUG	SEP

- 3rd JCC
- Final JCC
- Final Report
- Weather Disaster Seminar
- 2nd GTS/MSS Training
- Test Operation of Lighting Information Issuing
- 3rd Open School on Weather Disaster at Nuwara Eliya
- Internal Operation of 12 and 24hr Guidance Forecasting
- Survey on Upper-air Observation by Sort-term Expert
- Installation of HimawariCast Receiver
- Training on Instrument Calibration II by Short-term Experts
- SATAID Training by Sort-term Expert
- Installation of IP-VPN and restart of the operation of AWS

JICA Counter Parts Trainings in Japan

Progress

- Four train courses were implemented in Japan for the Counter parts of DOM in 2016 and 2017.

Details

1. Training course on Meteorological Instrument Calibration, RIC-Tsukuba, JMA, Japan, two weeks , February 2016, 4 DOM staff, coordinated by the JICA Long-term Expert.
2. Training course on Weather Forecasting and Weather Information Dissemination I , Gifu University , Japan, two weeks , February and March 2016, 4 DOM staff, coordinated by the JICA Consultant Experts.
3. Training course on Meteorological Observations, two weeks , February 2017, 8 DOM staff, coordinated by the JICA Long-term Expert.
4. Training course on Weather Forecasting and Weather Information Dissemination I I, Gifu University and Tsukuba University, Japan, two weeks , March 2017, 4 DOM staff coordinated by the JICA Consultant Experts.

Prospective Recommendations (Draft)

Overall Goal	
Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	
Output of PDM	Recommendations
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	• To conduct a technical training for the DOM staff in charge of the maintenance and inspection of the meteorological observation instruments using knowledge gained from this Project. • To establish close communication and association with the overseas Regional Instrument Center of the World Meteorological Organization (WMO). At the same time, to ensure the continued traceability of the meteorological observation instruments (atmospheric pressure & temperature) through the constant calibration of the domestic meteorological equipment. • To establish the traceability of the meteorological observation instruments for humidity, wind and precipitation introducing and using the standard DOM meteorological instruments and calibration equipment.
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	• To encourage and continue the maintenance of the observation fields (prevention of animal intrusion, etc.) and the environmental improvement of the observation rooms (installing an air conditioner). • In order to enhance and guarantee the continuous operation of the automatic weather observation systems (AWS) and to ensure the technical training of the electrical engineering staff, the establishment of appropriate measures against system failure, scheduled replacement of parts and a fully documented maintenance system with proper document control is indispensable. • To conduct technical training for new staff and periodic inspection by the manufacturing company for the stable operation of the GTS/Message Switching System (MSS).
3. Capacity of weather forecasting is improved using obtained meteorological data.	• Continuous recruitment of human resources for roles in forecast operation for the next generation. Simultaneously, the development of excellent weather forecasters need to be sustained by conducting forecast trainings within the DOM, encouraging staff to attend a training program abroad and supporting staff to earn Masters or Doctoral degrees. • To conduct accurate evaluation of the Local Numerical Weather Prediction WRF model aimed at actual operation, to put the Weather Guidance using the data of the WRF model/the Global Numerical Weather Prediction Model to practical use. • To accumulate the grid point values (GPV) after the calculation of the WRF model every day for the evaluation and the improvement of the model. • Continuous improvement of overall forecasting works taking in the knowledge and data of meteorology. • In order to understand real time local weather conditions across the country and utilize them for disaster prevention operations, it is imperative to transmit observation data of all the AWSs to the DOM Head Office without any delay for accurate evaluation of the Numerical Weather Prediction and Weather Guidance.
4. Warning criteria is elaborated.	• To create an updated, accurate and consistent database of meteorological disasters (disaster occurrence time, disaster location, damage situation, weather condition, weather information and transmission condition). • To conduct further research to increase the level of understanding/knowledge about meteorological disasters and its mechanisms along with other related meteorological phenomena. • To improve forecasting works relevant to meteorological disasters through the implementation of the above recommendations at the same time continually develop human resources capable of doing the verification and review of warning criteria.
5. The method of dissemination and contents of meteorological information are improved.	• In order to reduce natural disaster risk, it is important to improve the cooperation with organizations/agencies related to disaster management and mass media as the means for transmission of disaster information. • To conduct continuous public awareness activities about disaster prevention. • In order for the public to find weather information easier, it is necessary to improve the DOM's Website continuously. • To develop and recruit the human resources needed to implement the above recommendations. • To continuously conduct Open Class both in Colombo city and in local regions. • To continuously develop human resources within the DOM who can conduct Open Class. • To exchange ideas and opinions on a regular basis with stakeholders on the method of dissemination and the contents of meteorological information through the Monsoon Forum conducted biannually by the DOM, and try to feed back the results into the DOM's activity and products for further improvements. • To continuously inform availability of the renewed DOM website through the Monsoon Forum and Open Class.

Minutes of Meeting for the 4th Joint Coordinating Committees (JCCs)

MINUTES OF THE MEETING
OF THE 4th
JOINT COORDINATION COMMITTEE (JCC)
FOR THE
TECHNICAL COOPERATION PROJECT
FOR
"IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION"
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

The series of discussions on the above captioned project among the officials concerned of the Government of Sri Lanka and the Japan International Cooperation Agency (JICA) have been conducted under the chairmanship of Mr. S. S. Miyanawala, Secretary of the Ministry of Disaster Management. As the result of the discussions, both sides have confirmed the main items described in the attached documents.

Colombo, July 26, 2017

Fusao Tanaka
Chief Representative
Japan International Cooperation Agency
JICA Sri Lanka Office

Sarath Premalal
Director General
Department of Meteorology (DOM)

ATTACHMENT

1. Project Name

Technical Cooperation Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination in the Democratic Socialist Republic of Sri Lanka

2. Implementing Agency

Ministry of Disaster Management, Department of Meteorology (DOM), Sri Lanka and Japan International Cooperation Agency (JICA)

3. Opening Address of the Ministry of Disaster Management

The Secretary of the Ministry of Disaster Management expressed his appreciation to all the attendees of the JCC especially the cooperation of JICA for the improvement of the capabilities of the DOM and the significant contributions and recommendations of the JICA long term expert and consultant team.

4. Discussion of "the significant issues for the successful completion of the Project" presented by the JICA consultant team at the previous JCC meeting held on May 02, 2017

- The additional training on GTS/MSS
  The JICA consultant team conducted an additional training on the operation of the Global Telecommunication System Message Switch procured under the Project for 5 days between May 02 and May 06, 2017.

- Transition from the current VSAT system to the IP-VPN system.
  The DOM indicated that the contract of the IP-VPN service was already concluded and the transition from the current VSAT system to the IP-VPN system is smoothly going on now and the transition is expected to be completed by the end of September 2017. However, since some of the existing stations located in the mountainous area have some difficulties on the telecommunication environment, the transition to the IP-VPN system at those stations may be completed at the end of October 2017

5. Presentation of the first draft of the "Final Report of the Project"

The JICA consultant team and the JICA long term expert presented the first draft of the "Final Report of the Project (Consultant Team)" and requested the DOM to brush it up. As per the request, the DOM kindly agreed to do so.

6. Results of the Activities 1-5 and Achievements of the Project Purpose (Annex 3)

Each representative of the counterpart groups of Activities 1-5 of the DOM delivered a detailed explanation of the results of the activities and achievements made under the Project in accordance with the draft Project Brief Notes made by the JICA consultant team.

7. Recommendations towards the Achievement of the Overall Goal (Annex 4)

The JICA consultant team and the JICA long term expert communicated the recommendations towards the Achievement of the Overall Goal. The DOM indicated their appreciation to the JICA long term expert and the JICA consultant team.

8. Recommendations to the DOM for further mitigating the damages caused by natural disasters (Annex 4)

The JICA consultant team and the JICA long term expert communicated their recommendations to the DOM for further mitigating the damages caused by natural disasters. The DOM has indicated they will follow such recommendations as much as possible.

9. Other discussions (Annex 5)
Mr. Miyanawara presented some comments on the problems and issues in the weather services in Sri Lanka and discussions were made with all the attendees of the meeting.

10. Closing remarks of the Director General of the Department of Meteorology
The Director General of the Department of Meteorology expressed his appreciation to all the attendees of the JCC and the hard work done by all parties. Specifically, the valuable activities and recommendations of the JICA long term expert and consultant team for enhancing the capabilities of the DOM as well as the willingness and cooperation of the DOM to implement the project plans. The DOM will study the recommendations and execute the necessary as soon as possible.

Annex 1: Agenda
Annex 2: List of Attendees of the JCC
Annex 3: Actual Activities done under the Project by the DOM counterparts and the JICA team
Annex 4: Recommendations towards the Achievement of the Overall Goal and for further contribution for mitigating the damage caused by natural disasters made by the JICA consultant term and the JICA Long term expert
Annex 5: Other discussions

Annex 1

Agenda on the 4th Joint Coordinating Committee for the Project for Improving of Meteorological Observation, Weather Forecasting and Dissemination

Date: July 26, 2017
Venue: Conference Room, Ministry of Disaster Management
Time: 10:00

1. Opening Address: Secretary, Ministry of Disaster Management

2. Achievement of "the very important issues for the successful of the project" presented at the 3rd JCC (Consultant Experts)

3. General Description of "the 1st draft of the Final Report of the Project"
(Consultant Experts)

4. Discussion on Results of the Activities and Achievements of the Project Purpose
(DOM)

5. Discussion on Recommendations towards the Achievement of the Overall Goal
(Long-term Experts, Consultant Expert)

6. Discussion on Recommendations for further contribution for mitigating the damage caused by natural disasters by the DOM
(Long-term Expert, Consultant Expert)

7. Introduction of Project Brief Notes
(Consultant Experts)

8. Comments from the JICA Sri Lanka Office

9. Closing Remark: Project Director (Director General of the DOM)

END

PROJECT DESIGN MATRIX (PDM)

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Weather information disseminated from the DOM is well utilized by the public and the disaster related organizations.	1. Number of the civil work projects for disaster mitigation that fully or partly utilize the improved meteorological information from DOM. 2. Number of the community level early warning system, hazard maps or evacuation plans that fully or partly utilize the improved meteorological information from DOM.	- Annual reports from Disaster Management Centre (DMC), Irrigation Department, National Building Research Organization, Department of Fisheries and other relevant organizations - Interview with the above organizations - Weather forecast disseminated through mass media	
Project Purpose: Move accurate and timely meteorological information is disseminated to the public and the disaster related organizations.	1. Traceability of meteorology instruments (Availability of national standards/frequency of inspection) 2. Number of missing observation data. 3. Accuracy of rainfall forecast in the selected stations. 4. Number of selected station where weekly forecast is enabled in real basis.	- Annual administration reports of DOM - Record of the JCC meeting - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM	The government's policy to prioritize the disaster mitigation and reinforce relevant organizations including DOM is continued without significant changes.
Outputs: 1. Capacity on maintenance and calibration of meteorological observation equipment is improved. 2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened. 3. Capacity of weather forecasting is improved using obtained meteorological data. 4. Warning criteria is elaborated. 5. The method of dissemination and contents of meteorological information are improved.	1.1 Revision of the inspection and repairing (parts replacing) manual for AWS is completed during the Project. 1.2 Training on inspection and repairing of AWS is conducted for 70% of the relevant DOM staff. 2.1 Data from AWS are obtained and made available to a full extent in DOM. 2.2 Binary data via GTS are obtained and made available to a full extent in DOM during the Project. 3.1 At least 8 persons in DOM obtain ability to produce the short range and weekly weather forecast guidance. 3.2 At least 4 persons in DOM obtain ability to produce the weather forecast guidance of sea wind. 4.1 Number of areas where newly designed warning criteria that can meet the past disaster records are prepared. 5.1 Number of developed educational material for weather services. 5.2 Monthly access number of the DOM Website is increased by 30% or more.	- Annual administration reports of DOM - Record of the JCC meetings - Progress reports of the Project - Work reports of the short-term experts - Work reports of the consultant team - Website of DOM - The draft maintenance manual of meteorological equipment - Training records on maintenance of meteorological equipment - AWS data transmission records - Training records on the weather guidance (up to 36 hours ahead and 168 hours ahead) - Draft warning criteria - Educational material for weather services	Necessary budgets for maintaining meteorological equipment are allocated to DOM in 2015 and 2016.

Activities	Inputs		Pre-conditions
	(Japanese side)	(Sri Lanka side)	
1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments. 1.4 Conduct training on calibration of conventional and AWS equipment. 1.5 Review and revise the Standard Operation Procedure for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule. 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved. 2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters. 2.3 Review the current situation on GTS/MSS, and identify the issues to be improved. 2.4 Replace and upgrade the GTS/MSS. 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification. 3.3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations. 3.4 Produce weather forecast guidance of sea wind at the selected stations. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). 3.6 Verify and improve the existing methods of seasonal forecast. 3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data. 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning strike. 5.1 Review the contents of current meteorological information and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of Website. 5.5 Prepare smartphone compatible website. 5.6 Prepare educational materials (disaster awareness materials) for the weather services.	Short-term experts: - Expert of Meteorological Observation - Expert of Satellite Data Analysis Experts dispatched from the consultant: - Leader / Expert of Weather Forecasting - Expert Weather Guidance - Expert of Meteorological Observation Technology - Expert of Data Management / Information Technology - Expert of Weather Information Dissemination - Expert of Website - Project Coordinator / Weather Forecasting Assistant Machinery and Equipment: - Laptop PC for the training of weather guidance method - Laptop PC for downloading data from AWS logger - Display for Weather Briefing - Multifunction machine (Printer / Photocopy) - Printer - Portable Calibration System (Portable AWS(temperature, atmospheric pressure, humidity, wind direction and wind speed)) - Standard Meteorological Instrument (electric temperature and pressure sensor) - Spare parts for AWS - Laminating machine - Laptop PC for the training of editing a website - Software for editing a website - Additional lightning protection system - Public Address System for Open Class - Projector for Open Class - Spare bulb for Projector - Extension power cable for Open Class - GTS/Message Switching System (including installation, adjustment, and initial operation instruction)	Counterpart personnel: C/P personnel from the relevant divisions under DOM Facilities and Equipment: - Office space for the long-term experts and other experts at the DOM headquarters - Office furniture, facilities and equipment Budgetary Arrangement by DOM: Administration and local operation costs	training provided by the Project are secured.

Annex 2

LIST OF ATTENDEES OF THE JCC

JOINT COORDINATION COMMITTEE (JCC)
FOR
TECHNICAL COOPERATION PROJECT
FOR
IMPROVING OF METEOROLOGICAL OBSERVATION, WEATHER FORECASTING AND DISSEMINATION
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Location: Conference Room, Ministry of Disaster Management
Time: 10:00, May 26, 2017

No.	Name	Position	Signature
1	S.S. Mahawaruduge	Secretary	
2	K.M.S. Premasiri	Director (Admin)	
3	A.P. Jayasooriya	Deputy Director (Proj)	
4	Nalaka Kaluarachchi	Director	
5	A.L.K. Wijewardena	Deputy Director	
6	R.M.P. Fernando	Meteorologist	
7	E.A.I.B. Ekanayake	Meteorologist	
8	Yoichi Hane	JICA HQs	
9	AKATSU Kunio	JICA HQs	
10			

No.	Name	Position	Signature
11	Nobutaka Nagaoka	JICA Consultant Team	
12	Toshinobu ENDO	JICA Consultant Team	
13	Masato Ishihara	JICA Long-term Expert	
14	Yoshihisa UCHIDA	JICA Consultant Team	
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Annex 3-1

Output 1 Actual Activities done under the Project

Table: Actual Activities done under the Project

Outputs and Activates of the PDM	Actual Activities done under the Project
Outputs 1 Capacity on maintenance and calibration of meteorological observation equipment is improved. Activities 1.1 Review the current situation on maintenance and calibration of meteorological equipment and identify the issues to be improved. 1.2 Procure the necessary instruments for calibration of meteorological equipment, and establish team(s) for proper maintenance and calibration. 1.3 Establish the traceability of meteorological instruments. 1.4 Conduct training on calibration of conventional and AWS equipment. 1.5	<Review the current situation on the maintenance and calibration of meteorological equipment and identify the issues to be improved> ■ Through several discussions with the DOM and the Baseline Study conducted, the current issues indicated below to be improved upon were identified. - The instruments used for calibration of weather observation instruments were getting outdated. - The DOM did not have the equipment to be used for the calibration of weather observation instruments. - The standard instruments used for the calibration of meteorological observation instruments were not calibrated with international standard instruments for a long time. - There are no guidelines and manuals for the calibration of meteorological instruments. - The manuals for maintenance were not revised for a long time since the original document of the manuals for meteorological instruments were prepared in PDF format only and the revision based on the current situation cannot be done smoothly. ■ Baseline Survey Report was prepared and submitted to JICA and the DOM. <Procurement of the necessary instruments for the calibration of meteorological equipment> ■ All the required documents necessary for the procurement process including the technical specifications for the new instruments for the calibration of meteorological equipment were prepared. ■ Procurement of all the planned equipment and standard instruments necessary for the calibration has been completed. ■ Observation accuracy of the procured instruments was to be secured as follows. - Electric Thermometer: Calibration Certificate of the Laboratory certified by ISO/IEC17025 - Electric Barometer: JMA Certificate - Portable Automatic Weather Station: JMA Certificate <Establishment of a team responsible for proper maintenance and

Activity 1-1

Review and revise the Standard Operation Procedure for manual and AWS observations. 1.6 Review and revise inspection and repairing (parts replacing) user's guide for AWS. 1.7 Conduct training on inspection and repairing of AWS. 1.8 Review the upper air observation schedule.	calibration> ■ The team responsible for proper maintenance and calibration was established by the staff of the "Conventional Instrument and Observation Management Division" and "Electric Engineering Division." <Establish the traceability of meteorological instruments> (Activity of the JICA Long Term Expert) <Conduct training on calibration of conventional and AWS equipment> (Activity of the JICA Short Term Expert) <Training on the calibration of AWS> ■ "Calibration and Maintenance Manual for Meteorological Instruments (Draft)" and "Inspection Guideline for Meteorological Instruments (Draft)" were prepared. ■ Trainings on the calibration of AWS and Synop observation Station were conducted on "Portable Automatic Weather Station Operation Manual" prepared as part of "Calibration and Maintenance Manual for Meteorological Instruments (Draft)". ■ Based on the results and lessons learned about the training on calibration and maintenance of AWS and Synop observation stations, the "calibration and maintenance manual (draft) of meteorological instruments" and the "inspection guidelines for meteorological instruments (draft)" were revised. <Monitoring the state of the calibration and maintenance in accordance with the manuals and guidelines created> ■ Comparative observation based on the prepared "Portable Automatic Weather Station Operation Manual" has already been conducted at 8 existing observation stations and the remaining 14 observation stations are scheduled to be conducted within 2017. It was confirmed. ■ Cleaning inspections based on the prepared "Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System" have been conducted at all observation stations and the implementation rate was 95%. <Review and revise the Standard Operation Procedure for manual and AWS observations> ■ Revision of the "Observation Guideline" for manual observation by meteorological instruments was implemented. - Understanding of the situation of current meteorological observation (meteorological observation elements, observation equipment, observation time, etc.)

Activity 1-2

	- Review and revision of the existing Meteorological Observation Manual (including description on inspection of equipment) ■ Review and revision of the existing Meteorological Observation Manual (including description on inspection of equipment) - Extraction of important parts from equipment manufacturer creation manual - Adoption of photographs extensively for easy understanding <Review and revise the user's guide for the inspection and repair (parts replacement) of the AWS> ■ All manuals to be revised in the project were newly prepared in Microsoft Word Format (doc. format) which can be easily updated since the format of the electronic data of all the existing manuals was "pdf". ■ As a result of the discussions with the DOM, the user's guide for the inspection and repair (parts replacement) of the AWS were reviewed and revised mainly by improving the following items. - Visualization by inserting photos and figures; - Correction by model change of wind direction/speed sensor; - Descriptions of inspection items (grounding resistance measurement etc.) added after the handover of the Automatic Weather Observation System (AWOS) procured under Japan's grant aid; and, - Selection and editing of the most important parts from the existing manuals. ■ Using the revised manual, the training on inspection and repair was conducted for the following staff. - For Electric Engineering Division and Conventional Instrument and Observation Management Division 1) Cleaning/Inspection Procedure including the preparation of the Cleaning/Inspection Report. 2) Preventive Maintenance Record - For Electric Engineering Division 1) Troubleshooting and Inspection Procedure 2) Spare Parts Replacement Procedure for Recovery ■ Construction of an additional lightning protection pole which is needed at three particular sites (Ratnapura, Polonnaruwa, and Aralagaonwila) vulnerable to lightning strikes were conducted through practical trainings. <Review the upper air observation schedule> (Activity of the JICA Long Term Expert)

Activity 1-3

Details of the PDM Outputs under the Project

■ Output 1 Capacity on maintenance and calibration of meteorological observation equipment is improved.

<Establish the traceability of meteorological instruments>

(Activity of the JICA Long Term Expert)

<Conduct training on calibration of conventional and AWS equipment>

(Activity of the JICA Short Term Expert)

Description of the "Calibration and Maintenance Manual for Meteorological Instruments (Draft)"

<Maintenance>

- ✧ Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System
- ✧ Preventive Maintenance Record for Automatic Weather Observation System
- ✧ Trouble Shooting and Inspection Procedure for Automatic Weather Observation System
- ✧ Spare Parts Replacement Procedure for Recovery of Automatic Weather Observation System

<Calibration>

- ✧ Manual for Meteorological Instrument Calibration 1 and 2
- ✧ Portable Automatic Weather Station Operation Manual

Description of the "Inspection Guideline for Meteorological Instruments (Draft)"

- ✧ Guideline and Manuals for Instrument Calibration

<Review and revise the Standard Operation Procedure for manual and AWS observations>

As the result of the survey on the existing weather observation provisions (observation elements, observation order, observation time, routine observation procedure; observation

Activity 1-4

time and weather observation value, report allowable time range) and the existing meteorological instruments and the automatic weather observation system, the preparation of the following manuals were implemented.

(1) Observation Guidelines including the rules necessary for meteorological observation (observation elements, observation order, observation time, routine observation procedure; observation time and weather observation value, report allowable time range), beaufort scale, cloud types for observers, etc.

(2) Portable Automatic Weather Station Operation Manual for the verification of the observation accuracy of the meteorological instruments and the automatic weather observation systems.

<Review and revise the user's guide for the inspection and repair (parts replacement) of the automatic weather observation system>

In accordance with the following procedures, the review and revision of the "Cleaning/Inspection Procedure including Cleaning/Inspection Report for Automatic Weather Observation System" and "Preventive Maintenance Record for Automatic Weather Observation System" were implemented.

1) Implementation of inspection on trial base with the DOM using existing manual
2) Identification of the points to be revised from the existing manuals
3) Implementation of the experimental re-inspection using the revised manual
4) Implementation of re-verification of revised content and proofreading

In accordance with the following procedures, the review and revision of the "Troubleshooting and Inspection Procedure for Automatic Weather Observation System" and "Spare Parts Replacement Procedure for Recovery" were implemented.

1) Preparation of simulated fault condition using real equipment
2) Validation of inspection procedure using existing operation and maintenance manual

3) Identification of the points to be revised from the existing operation and maintenance manuals
4) Implementation of re-verification of revised content and proofreading

Since the existing operation and maintenance manual (prepared by the equipment manufacturer) of the automatic weather observation system had considerable thickness and is composed of several volumes, it was difficult to figure out the required section/s needed and peruse it carefully. Therefore, it was not used frequently in daily maintenance. Only the important page is selected as an outline, a photograph or a diagram is newly inserted so that it is easy to understand, and "Troubleshooting and Inspection Procedure for Automatic Weather Observation System" and "Spare Parts Replacement Procedure for Recovery" were reedited.

<Training on the inspection and repair of Automatic Weather Observation System>

Since three observation stations, Ratnapura, Polonnaruwa and Aralagatenwila, had frequent problems due to lightning strikes in the Automated Weather Observation System and communication system that was established through grant aid from Japan, the installation of the following additional lightning protection facilities were implemented through practical training in this project.

- Lightning Rod: 15m height
- Connection between lightning rod and earth rod: Copper flat bar
- Grounding Type: "Common Earth" with additional earth rod and existing earth rod interconnected
- Earth resistance value: 5Ω or less

Table 8: Number of failures of the equipment due to lightning

	Before installation of Additional Lightning Protection (November 2009 – February 2015)	After installation of Additional Lightning Protection (February 2015 – November 2016)
Frequency of damage caused by lightning at Ratnapura, Polonnaruwa and Aralagatonwila	9 times	None

Using the prepared manuals, trainings were conducted for the engineers of the Electronic Engineering Division, the Observation Instrument & Observation Management Division and the responsible officer from the local weather observation stations.

<Review the upper air observation schedule>

(Activity of the JICA Long Term Expert)

Annex 3-2

Output 2 Actual Activities done under the Project

Table: Actual Activities done under the Project

Outputs and Activates of the PDM	Actual Activities done under the Project
Outputs 2 Transmitting and receiving capacity of various kinds of meteorological data is strengthened. Activities 2.1 Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved.	<Review the current situation on transmitting and receiving of observed data between AWS sites and the headquarters of DOM, and identify the issues to be improved> ■ Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified. ◦ Operation of the existing VSAT satellite data communication system is unstable, and it is frequently discontinued. ◦ VSAT satellite data communication system manufactured by Gilat Satellite Networks Ltd. of Israel. ◦ Since the communication satellite (INSAT3E) currently in use has already passed its service life of 10 years, it needs to be replaced within the next few years as its communication performance has deteriorated. ◦ For migration of the communication satellite with a new one, technical supports from the Gilat agent in India is indispensable and the cost (communication satellite replacement assisting cost) was estimated to be about 10.3 million yen (100,000 USD including one-year support) ■ Baseline Survey Report was prepared and submitted to the JICA and the DOM.
2.2 Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters.	<Examine the backup mode for the data transmitting and receiving between AWS sites and the headquarters> ■ As a result of the discussion with the DOM, the transmission method for the AWOS observation data was to be considered by the following policy. ◦ Since the cost of technical support from Gilat Agent in India was too expensive and the reliability of the existing VSAT satellite data communication system was also low, DOM decided to stop the operation the existing VSAT satellite data communication system after exhausting the own spare parts. ◦ As an alternative communication means, IP-VPN was the top priority. The examination is carried out while comparing with SMS and GPRS. ■ The trial test on the possible backup means (IP-VPN utilizing a ground communication network) for the transmission and receipt of observation data in order to observe weather phenomena on a real-time basis has been successfully completed. The new communication method was decided as IP-VPN.
2.3 Review the current situation on GTS/MSS, and identify the issues to be improved.	
2.4 Replace and upgrade the GTS/MSS.	

	▪ The Network Diagram of the before and after scenario on the change of the system network which utilized the IP-VPN has been prepared and presented. ▪ Technical specifications for selecting companies that provide IP-VPN services were prepared. ▪ A Flowchart was prepared with DOM for the smooth transition from the current VSAT system to the IP-VPN system.
	<Review the current situation on GTS/MSS, and identify the issues to be improved> ▪ Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified. ▪ Procurement of spare parts was difficult since the support period by the hardware (PC) manufacturer was already expired. ▪ The exiting GTS/MSS did not support the BUFR format, which is the international meteorological code newly designated by the World Meteorological Organization (WMO), and recommended by the member countries. ▪ Baseline Survey Report was prepared and submitted to the JICA and the DOM.
	<Replace and upgrade the GTS/MSS> ▪ Technical Specification Sheet required for the procurement of GTS/MSS was prepared by the DOM and Consultant. ▪ All required documents for the procurement by JICA were prepared and submitted to JICA with the Technical Specification Sheet. ▪ The installation and operation & maintenance training at the DOM Head Office by the equipment supplier's engineers were conducted. ▪ The training on standard operation of GTS/MSS and setting method on the software module for receiving WAFS (World Area Forecast System) Data by the Secure SADIS (Satellite Distribution System) FTP were conducted.

Details of the PDM Outputs under the Project

- Output 2: Transmitting and receiving capacity of various kinds of meteorological data is strengthened.

<Backup of the existing VSAT system for observation data transmission between Automatic Weather Observation System and the DOM office>

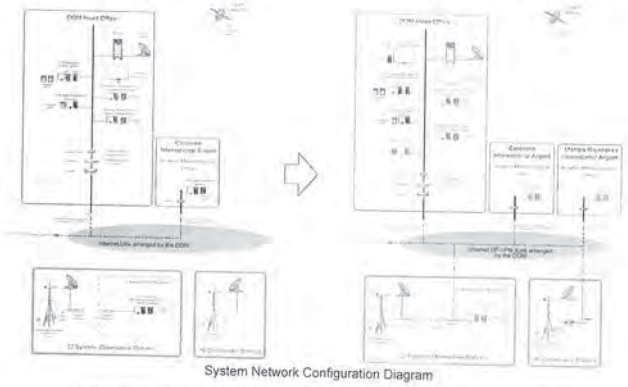
The following items concerning the backup of the existing VSAT system for transmitting the observation data between the Automatic Weather Observation System and the DOM Head Office were examined. As a result, it was decided to adopt IP-VPN as the backup of the existing VSAT system.

1) Confirmation of available communication methods for observation data transmission of the existing Automatic Weather Observation System
2) Confirmation of service area, fee, failure rate etc. of various communication services from the communication service providers in Sri Lanka
3) Implementation of transmission/reception experiment of observation data

A system network configuration diagram before and after the change to the system network using IP-VPN is attached hereunder.

<Before>

<After>



System Network Configuration Diagram

The required technical specifications for selecting an IP-VPN service provider and a procedure flow chart for transitioning from the VSAT system to IP-VPN attached below were prepared.

Operation Flow Chart for the Transition from VSAT to IP VPN

Complete !!

<Replacement of the existing GTS Message Switch System>

Technical Specifications of a new GTS Message Switch System necessary for the procurement procedures were prepared and the following equipment was procured by JICA. Equipment installation work and training completed on 18th December 2015.

- GTS Message Switch System
- Serial port Terminal Server
- Data Input Terminal
- Firewall Unit
- Compact Uninterruptible Power Supply

Training on the operation and maintenance of GTS Message Switch System by the equipment supplier engineers was implemented.

- First Training
  Schedule: December 10 – December 18, 2015
  Training Content: Operation and Maintenance of GTS Message Switch System

- Second Training
  Schedule: May 02 – May 06, 2017
  Training Content: Training on Operation of the Global Telecommunication System Message Switch (Visual Weather, Moving Weather module of the Global Telecommunication System Message Switch) and Access of WAFS (World Area Forecast System) data via the Secure SADIS FTP, BUFR Data Transmission

Output 3 Actual Activities done under the Project

Table: Actual Activities done under the Project

Outputs and Activates of the PDM	Actual Activities done under the Project
Outputs 3 Capacity of weather forecasting is improved using obtained meteorological data. Activities 3.1 Review the current situation on weather forecasting and identify the issues to be improved. 3.2 Conduct the training on the development of short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance and verification. 3.3 Produce short range (every 12 hours precipitation up to 36 hours ahead) and weekly (7 days ahead) weather forecast guidance at the selected stations.	<Review the current situation on weather forecasting and identify the issues to be improved> ■ Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified. - Acquisition of the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka (DOM WRF) at the National Weather Center was impossible. - The DOM had no experience for production of Weather Forecast Guidance. - Weather forecasts of the DOM were qualitative (not quantitative). - Meteorological Satellite Images of Chinese Fengyun (FY) and Communication, Ocean and Meteorological Satellite (COMS) of Korea were directly received for forecasting (Japanese Meteorological Satellite, Himawari could not be received). - The Grid Point Value of the Numerical Weather Prediction (NWP) of Japan Meteorological Agency (JMA) was not received for forecasting. - Number of the DOM personal who can operate Linux system was a few. ■ Baseline Survey Report was prepared and submitted to the JICA and the DOM. <Training for Weather Forecast Guidance> ■ Procurement of the PCs for Weather Forecast Guidance was implemented. ■ Configuration of the procured PCs was conducted through the trainings. ■ Collections of the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka (DOM WRF) and the observation data of the AWSs for the production of short range weather forecast guidance was completed and the database was implemented. ■ Collections of the Grid Point Value of the GFS (NOAA Global Forecast System) for the production of weekly (7 days ahead) weather forecast guidance was completed and the database was implemented. ■ The following trainings on Weather Forecast Guidance were conducted. - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for 1 Year - Short Range (Colombo Mesh: every 12 hours up to 36 hours ahead)

Activity 3-1

3.4 Produce weather forecast guidance of sea wind at the selected stations. 3.5 Conduct training on Satellite Animation and Interactive Diagnosis (SATAID). 3.6 Verify and improve the existing methods of seasonal forecast. 3.7 Conduct on-the-job training on improvement of weather forecasting operation through integration of various data.	Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for 1 Year - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the First Intern-Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Southwest Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Northeast Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Second Intern-Monsoon Season - Weekly (144h-168h) Weather Forecast Guidance (Colombo and Ratnapura) for Precipitation with the GFS (NOAA Global Forecast System) Grid Point Vale of 0.5 degree mesh data - Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale <Production of Weather Forecast Guidance> ■ Comparison between the DOM WRF Grid Point Vale and the GFS (NOAA Global Forecast System) for the Data Accuracy was implemented. ■ Production of the following Weather Forecast Guidance was implemented. - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the First Intern-Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Southwest Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Northeast Monsoon Season - Short Range (Colombo and Ratnapura: every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale for the Second Intern-Monsoon Season - Weekly (144h-168h) Weather Forecast Guidance (Colombo and Ratnapura) for Precipitation with the GFS (NOAA Global Forecast System) Grid Point Vale of 0.5 degree mesh data

Activity 3-2

	- Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale ■ Trail operation of Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the WRF Grid Point Vale was commenced. <Monitoring of Weather Forecast Guidance> ■ Revision/improvement of Semi-automatic Linux Program for Short Range (Colombo: every 12 and 24 hours) Weather Forecast Guidance for Precipitation with the DOM WRF Grid Point Vale was implemented. ■ Discussions with the DOM regarding smooth acquisition of the DOM WRF Grid Point Vale at the National Weather Center in the DOM Head Office were conducted. ■ Acquisition of the DOM WRF Grid Point Vale at the National Weather Center was realized. <Trainings on Sea Wind Weather Guidance> ■ Collections of the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka and the observation data of the AWSs for the production of short range weather forecast guidance was completed and the database was implemented. ■ Production of Short Range (Puttalam and Pothuvil: 24 hours and 48 hours ahead) Sea Wind Weather Guidance with the DOM WRF Grid Point Vale was implemented. ■ Trainings on Sea Wind Weather Forecast Guidance were conducted. <Conduct training on Satellite Animation and Interactive Diagnosis (SATAID)> (Activity of the JICA Long Term Expert) <Seasonal Weather Forecast> ■ Production and verification of Seasonal Weather Forecast Guidance for Precipitation (by 2040) with sea surface temperature observation data at 5 selected points in Pacific, Indian and Atlantic Oceans and rainfall observation data of Colombo for 36 years with the CFS (NOAA Climate Forecast System) Grid Point Vale was completed. ■ Verification of Seasonal Weather Forecast Guidance for Precipitation was implemented for 15 months. <On-the-job training on improvement of weather forecasting operation through integration of various data> ■ Installation trainings of VMware, Linux (CentOS) and Wgrib2 were implemented. ■ Trainings for downloading reanalysis data and extraction of the required

Activity 3-3

	CSV data and other products from grib2 data of the global meteorological organizations (NOAA Climate Forecast System, etc.) which is useful for NWP model operation were implemented. ■ Trainings for preparation of attractive forecast products with Power Point were implemented. <Monitoring of Weather Forecasts> ■ Discussions with the DOM on preparation and issuance of Weather Forecasts were conducted. ■ Contents of the weather briefings of the DOM were improved with various kind of data from Overseas, meteorological satellite data of Himawari (a Japanese meteorological satellite), products of the DOM WRF.

Activity 3-4

Details of the PDM Outputs under the Project

- Output 3: Capacity of weather forecasting is improved using obtained meteorological data.

<Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Short Range (every 12 hours up to 36 hours ahead) Weather Forecast Guidance for precipitation was produced.

(1) Comparison between the DOM WRF Grid Point Vale and the GFS (NOAA Global Forecast System) for the Data Accuracy

Comparison of "Multiple Correlation Coefficient" and "Intercept" between the DOM WRF Grid Point Vale (GPV) and the GFS (NOAA Global Forecast System) for the Data Accuracy with observation data of the existing automatic weather observation systems (AWS) was implemented. The results are as shown in the table below. According to the result, the Grid Point Value of the Regional NWP Model (WRF) of Sri Lanka (DOM WRF) was used for the Weather Forecast Guidance.

Table 9: Comparison of "Multiple Correlation Coefficient" and "Intercept" between the DOM WRF Grid Point Vale (GPV) and the GFS (NOAA Global Forecast System) for the Data Accuracy

	GPV of the Regional NWP Model (WRF) of Sri Lanka	GPV of GFS (NOAA Global Forecast System)
Multiple Correlation Coefficient	0.839	0.763
Intercept	9.966	10.979

(2) Grid Point Distance of the DOM WRF Grid Point Vale: 10km

(3) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC and 12UTC
- Real observation time corresponding to the forecast target time: 06:00 and 18:00 (Local Time of Sri Lanka)

(4) Selected Forecast Point of the Weather Forecast

North-East Monsoon

2nd Inter Monsoon

1st Inter Monsoon

South-West Monsoon

for Colombo rainfall (24 hours) between April 4, 2017 and July 18, 2017, the root mean square error between the forecast value and the observation value was 13.1 mm.

<Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance>

In accordance with the following procedures, the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance for precipitation was produced.

(1) Grid Point Distance of the DOM WRF Grid Point Vale: 10km

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Puttalam and Pothuvil

(4) As a result of analysis and examination, it was clarified that the accuracy of Weather Forecast Guidance was improved by dividing into 4 Monsoon Seasons. For this reason, it was decided to carry out the Weather Forecast Guidance separately for each Monsoon Season.

(5) The predictors that give the highest Multiple Correlation Coefficient were extracted by the developed program. Details of the predictors used for the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance are shown in Annexes 2.

(6) Confirmation of the accuracy of the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance

In order to confirm the accuracy of the Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance, Multiple Correlation Coefficient and Root Mean Square Error (RMSE) by dividing into 4 Monsoon Seasons were calculated. The results are as shown in the tables below

Table 16: Multiple Correlation Coefficient of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Puttalam (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.64	0.56
1st Inter Monsoon	0.70	0.63
South-West Monsoon	0.73	0.72
2nd Inter Monsoon	0.68	0.65

Table 17: Multiple Correlation Coefficient of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Pothuvil (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.75	0.70
1st Inter Monsoon	0.74	0.67
South-West Monsoon	0.65	0.69
2nd Inter Monsoon	0.69	0.74

Table 18: Root Mean Square Error (RMSE) of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Puttalam (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.6m/s	0.6m/s
1st Inter Monsoon	0.5m/s	0.6m/s
South-West Monsoon	0.4m/s	0.4m/s
2nd Inter Monsoon	0.7m/s	0.7m/s

Table 19: Root Mean Square Error (RMSE) of Short Range (24 hours and 48 hours ahead) Sea Wind Weather Forecast Guidance at Pothuvil (4 Monsoon Seasons)

Monsoon Season	24 hours Sea Wind Forecast	48 hours Sea Wind Forecast
North-East Monsoon	0.5m/s	0.5m/s
1st Inter Monsoon	0.7m/s	0.7m/s
South-West Monsoon	1.3m/s	0.9m/s
2nd Inter Monsoon	0.8m/s	0.7m/s

<Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation was produced.

(1) Grid Point Distance of the GFS (NOAA Global Forecast System) Grid Point value: 0.5 degree

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Colombo and Ratnapura

(4) As a result of analysis and examination, it was clarified that the accuracy of Weather Forecast Guidance was improved by dividing into 4 Monsoon Seasons. For this reason, it was decided to carry out the Weather Forecast Guidance separately for each Monsoon Season.

(5) The predictors that give the highest Multiple Correlation Coefficient were extracted by the developed program. Details of the predictors used for the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation are shown in Annexes 2.

(6) Confirmation of the accuracy of the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation

In order to confirm the accuracy of the Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation, Multiple Correlation Coefficient and Root Mean Square Error (RMSE) by dividing into 4 Monsoon Seasons were calculated. The results are as shown in the tables below

Table 20: Multiple Correlation Coefficient of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	0.44
1st Inter Monsoon	0.32
South-West Monsoon	0.353
2nd Inter Monsoon	0.33

Table 21: Multiple Correlation Coefficient of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	0.40
1st Inter Monsoon	0.44
South-West Monsoon	0.46
2nd Inter Monsoon	0.26

Table 22: Root Mean Square Error (RMSE) of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Colombo (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	9.9mm
1st Inter Monsoon	14.0mm
South-West Monsoon	
2nd Inter Monsoon	

Table 23: Root Mean Square Error (RMSE) of Weekly (144h-168h ahead) Weather Forecast Guidance for Precipitation at Ratnapura (4 Monsoon Seasons)

Monsoon Season	24hours Precipitation Forecast
North-East Monsoon	8.6mm
1st Inter Monsoon	11.3mm
South-West Monsoon	
2nd Inter Monsoon	

<Seasonal Weather Forecast Guidance for Precipitation>

In accordance with the following procedures, the Seasonal Weather Forecast Guidance for Precipitation was produced.

(1) Grid Point Distance of the CFS (NOAA Climate Forecast System) Grid Point value: 0.5 degree

(2) Time of Observation Data and NWP Data used for the Weather Forecast Guidance

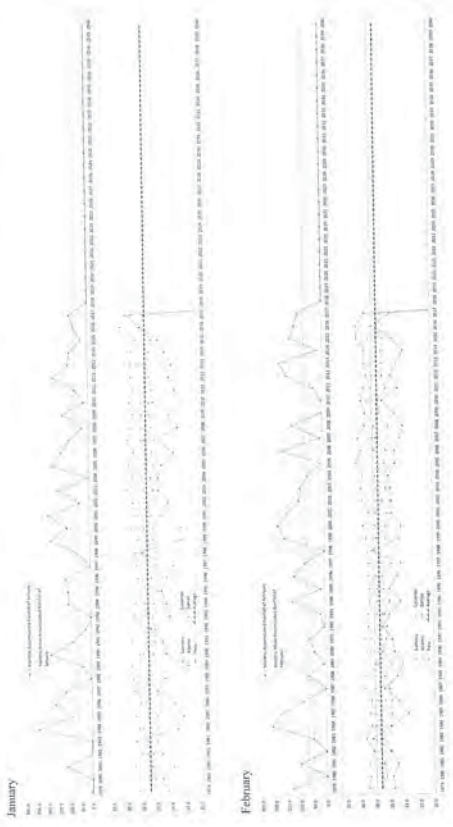
- Forecast target time of NWP data: 00UTC
- Real observation time corresponding to the forecast target time: 06:00 (Local Time of Sri Lanka)

(3) Selected Forecast Point of the Weather Forecast Guidance: Colombo and Ratnapura

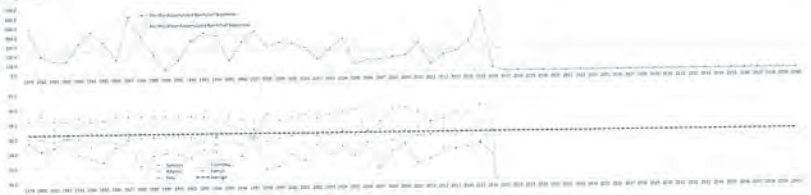
(4) The predictors used for the Seasonal Weather Forecast Guidance for Precipitation

Sea Surface Temperature (SST) up to 9 months ahead of the NOAA Climate Forecasting System at 5 points indicated on the map below.

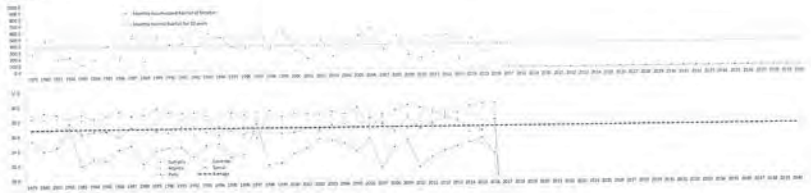
(5) Annual variation of Monthly Mean Accumulated Rainfall at Colombo and Monthly Mean Sea Surface Temperatures (SST) at 5 Points in the World



September

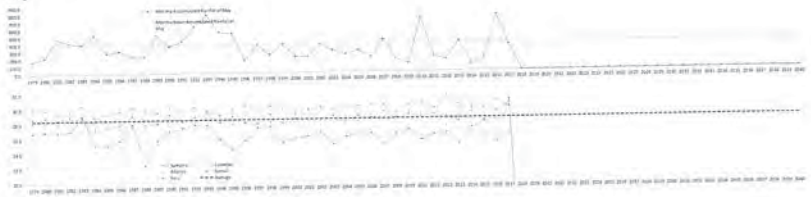


October

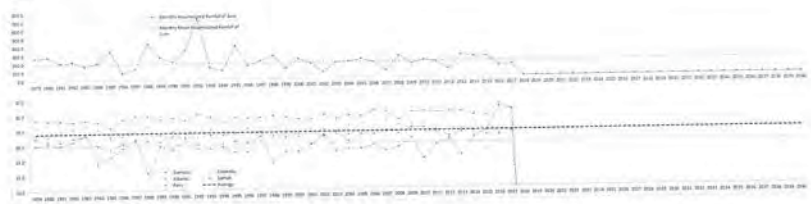


Activity 3-17

May

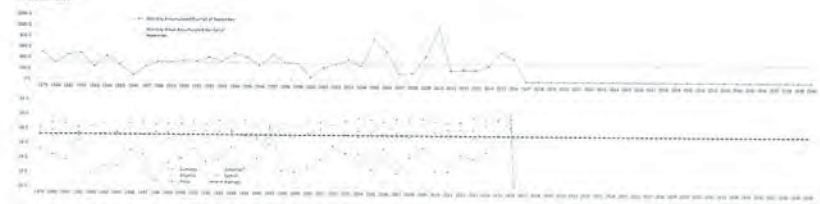


June

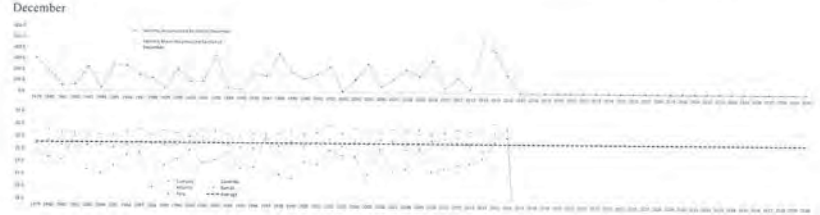


Activity 3-15

November

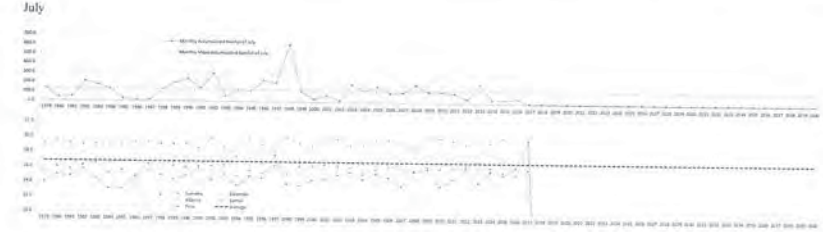


December

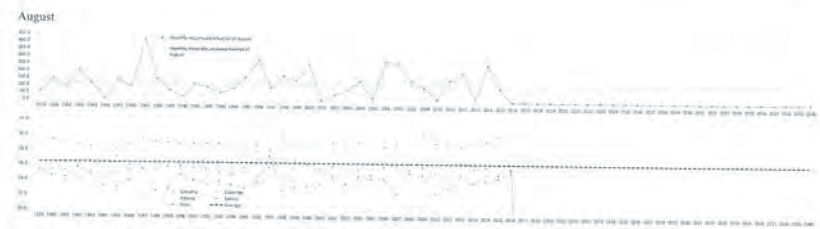


Activity 3-18

July



August



Activity 3-16

Annex 3-4

Output 4 Actual Activities done under the Project

Table: Actual Activities done under the Project

Outputs and Activates of the PDM	Actual Activities done under the Project
Outputs 4 Warning criteria is elaborated. Activities 4.1 Review the current situation on warnings, and identify the areas to be improved. 4.2 Examine methods for the improvement of criteria through discussion with DOM, DMC, Dept. of Fisheries, etc. and make new criteria for heavy rainfall, strong winds and lightning strike.	<Review the current situation on weather forecasting and identify the issues to be improved> ■ Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified. ◦ Current issuance of advisory/warning is universally applied all over the country using the same criteria. ◦ The advisory/warning signs are not comprehensible for the public. ◦ The advisory/warning bulletin is mainly stated as textual information and difficult. ■ Baseline Survey Report was prepared and submitted to the JICA and the DOM. <Preparation of New advisory/warning criteria of heavy rain/strong wind and advisory criteria for lightning> ■ Collection of weather observation data and disaster events has been conducted. ■ Introduction of JMA advisory and warning has been made. ■ Existing advisory/warning criteria of heavy rain and strong wind have been verified using weather observation data and disaster information. ■ Revised advisory/warning criteria for heavy rainfall has been set at each climatic/geographical zone. ◦ Approach1: Statistical analysis using both the disaster records and AWS/raingauge rainfall data. (Using disaster events whose locations are within 10km from the nearest AWS/raingauge) ◦ Approach2: Statistical analysis using both the disaster records and AWS/raingauge rainfall data. (Without considering the distance between the place where the disaster occurred and the nearest AWS/raingauge) ◦ Approach3: Statistical analysis using AWS/raingauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning/advisory.) ◦ Approach4: Statistical analysis using AWS/raingauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical

Activity 4-1

	areas as possible criteria for heavy rain warning/advisory.) ■ Revised advisory/warning criteria for strong wind has been set. ◦ Approach1: Statistical analysis using both the disaster records and AWS wind speed data. (Using disaster events whose locations are within 10km from the nearest AWS) ◦ Approach2: Statistical analysis using both the disaster records and AWS wind speed data. (Without considering the distance between the place where the disaster occurred and the nearest AWS) ◦ Approach3: Statistical analysis using AWS wind speed data. (In consequence of discussion with DOM, sort all the hourly wind speed data in descending order for each AWS station. Assume the averaged 99th/95th percentiles of the wind speed data as possible criteria for strong wind warning/advisory.) ■ Newly advisory criteria for lightning has been set. ◦ Approach1: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (Assume the averaged CAPE and SSI data as possible criteria for lightning advisory at Dry Zone, Wet + Intermediate Zone and Whole country.) ◦ Approach2: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (In consequence of discussion with DOM, sort all CAPE and SSI data in descending order for each SYNOP station. Assume the averaged 99th percentiles of the CAPE and SSI data as possible criteria for lightning advisory. ■ Internal operation of revised warning criteria of heavy rain and strong wind have been conducted in the period of rainy season (1st inter-monsoon season, 2017). ■ The advisory/warning signs (Heavy Rain, Lightning, Strong Wind, Cyclone & Tsunami) have been improved in compliance with the universal design and which are comprehensible for anyone. ■ The advisory/warning bulletin have been improved from TEXT product to VISUAL product.

Activity 4-2

Details of the PDM Outputs under the Project

■ Output 4: Warning criteria is elaborated.

<Preparation of New advisory/warning criteria of heavy rain/strong wind and advisory criteria for lightning>

Revised advisory/warning criteria for heavy rainfall has been set at each climatic/geographical zone.

(1) Approach 1: Statistical analysis using both the disaster records and AWS/rain gauge rainfall data. (Using disaster events whose locations are within 10km from the nearest AWS/rain gauge)

Data used for the analysis:
- AWS rainfall data (hourly) at thirty-eight (38) SYNOP and AWS stations.
- Rain gauge rainfall data (daily) at about three hundred (300) stations.
- Disaster events recorded by the DMC (death toll due to flood, landslide and cyclone): 462 events.

Period in scope of the analysis:
January 1978 to December 2014

Method:
- Extract disaster events due to flood: 462 → 199 events.
- Extract disaster events whose locations are within 10km from the nearest AWS/rain gauge: 199 → 114 events.
- Extract maximum daily rainfall observed by the AWS/rain gauge during the 5 days prior to the occurrence of each disaster.
- Classify the AWS/rain gauge stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Sort the extracted AWS/rain gauge daily rainfall data in descending order for the two climate zones.
- Assume the 40th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the 50th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone: Advisory > 70mm/24h + 50mm/6h
Warning > 100mm/24h

Activity 4-3

Criteria for Wet + Intermediate Zone: Advisory > 100mm/24h + 50mm/6h
Warning > 120mm/24h

(2) Approach 2: Statistical analysis using both the disaster records and AWS/rain gauge rainfall data. (Without considering the distance between the place where the disaster occurred and the nearest AWS/rain gauge)

Data used for the analysis:
- AWS rainfall data (hourly) at thirty-eight (38) SYNOP and AWS stations.
- Rain gauge rainfall data (daily) at about three hundred (300) stations.
- Disaster events recorded by the DMC (death toll due to flood, landslide and cyclone): 462 events.

Period in scope of the analysis:
January 1978 to December 2014

Method:
- Extract disaster events due to flood: 462 → 199 events.
- Extract maximum daily rainfall observed by the AWS/rain gauge during the 5 days prior to the occurrence of each disaster.
- Classify the AWS/rain gauge stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Sort the extracted AWS/rain gauge daily rainfall data in descending order for the two climate zones.
- Assume the 40th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the 50th percentile of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone: Advisory > 70mm/24h + 50mm/6h
Warning > 100mm/24h

Criteria for Wet + Intermediate Zone: Advisory > 90mm/24h + 50mm/6h
Warning > 120mm/24h

(3) Approach 3: Statistical analysis using AWS/rain gauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning/advisory.)

Activity 4-4

Data used for the analysis:

- Before the operation of the AWS:
  Rain gauge rainfall data (daily) at selected twenty (20) SYNOP stations.
- After the operation of the AWS:
  AWS rainfall data (hourly) at selected twenty (20) stations co-located at the SYNOP stations.

Period in scope of the analysis:
January 1978 to December 2014

Method:

- Sort all the daily rainfall data during the period in scope of the analysis in descending order for each SYNOP station.
- Extract the 95th percentile of the daily rainfall data for each SYNOP station.
- Extract the 99th percentile of the daily rainfall data for each SYNOP station.
- In case daily rainfall data is missing (-999) or daily rainfall is below 0.1mm/24h, those data are not included in the statistical analysis.
- Classify the SYNOP stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Assume the area-averaged 95th percentiles of the daily rainfall data for the two climate zones as possible criteria for heavy rain advisory.
- Assume the area-averaged 99th percentiles of the daily rainfall data for the two climate zones as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Dry Zone:	Advisory > 55mm/24h	
	Warning > 100mm/24h	
Criteria for Wet + Intermediate Zone:	Advisory > 45mm/24h	
	Warning > 85mm/24h	

(4) Approach 4: Statistical analysis using AWS/rain gauge rainfall data. (In consequence of discussion with DOM, sort all the daily rainfall data in descending order for each SYNOP station. Assume the area-averaged 99th/95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning/advisory.)

Data used for the analysis:

- Before the operation of the AWS:
- Rain gauge rainfall data (daily) at selected twenty (20) SYNOP stations.
- After the operation of the AWS:

- AWS rainfall data (hourly) at selected twenty (20) stations co-located at the SYNOP stations.

Period in scope of the analysis:
January 1978 to December 2014

Method:

- Sort all the daily rainfall data during the period in scope of the analysis in descending order for each SYNOP station. (Same as Method 1 of Approach No. 3)
- Extract the 95th percentile of the daily rainfall data for each SYNOP station.
- Extract the 99th percentile of the daily rainfall data for each SYNOP station.
  * In case daily rainfall data is missing (-999) or daily rainfall is below 0.1mm/24h, those data are not included in the statistical analysis.
- Classify the SYNOP stations into two geographical areas: Mountain area and Plain area.
- Assume the area-averaged 95th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain advisory.
- Assume the area-averaged 99th percentiles of the daily rainfall data for the two geographical areas as possible criteria for heavy rain warning.

Results of the Analysis:

Criteria for Mountain Area:	Advisory > 35mm/24h	
	Warning > 65mm/24h	
Criteria for Plain Area:	Advisory > 50mm/24h	
	Warning > 100mm/24h	

Prospective Warning Criteria (Heavy Rain)

Climate Zone	Approach No.1 Criteria (Disaster Event Analysis)	Approach No.2 Criteria (Disaster Event Analysis)	Approach No.3 Criteria (Statistical Analysis)	Approach No.4 Criteria (Statistical Analysis)	Geographical Area
Wet Zone + Intermediate Zone	Advisory R > 50mm/6h & R > 100mm/24h	Advisory R > 50mm/6h & R > 90mm/24h	Advisory R > 45mm/24h	Advisory R > 35mm/24h	Mountain Area
	Warning R > 120mm/24h	Warning R > 120mm/24h	Warning R > 85mm/24h	Warning R > 65mm/24h	
Dry Zone	Advisory R > 50mm/6h & R > 70mm/24h	Advisory R > 50mm/6h & R > 80mm/24h	Advisory R > 55mm/24h	Advisory R > 50mm/24h	Plain Area
	Warning R > 100mm/24h	Warning R > 90mm/24h	Warning R > 100mm/24h	Warning R > 100mm/24h	
Whole Country	Existing Criteria: Advisory R > 50mm/6h & R > 100mm/24h; Warning R > 150mm/24h				

Revised advisory/warning criteria for strong wind has been set.

(1) Approach 1: Statistical analysis using both the disaster records and AWS wind speed data. (Using disaster events whose locations are within 10km from the nearest AWS)

Data used for the analysis:

- AWS wind speed data (hourly, average/gust wind speed) at selected twenty (20) stations co-located at the SYNOP stations.
- Disaster events recorded by the DMC (death toll, destroyed and damaged houses due to strong wind): 703 events.

Period in scope of the analysis:
January 2009 to December 2014

Method:

- Extract disaster events whose locations are within 10km from the AWS: 703 → 144 events.
- Extract maximum average/gust wind speed data observed by the AWS 48 hours prior to the occurrence of each disaster.
- Sort the above extracted AWS wind speed data (144 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind

advisory.

- Assume 95th percentile of the wind speed data as possible criteria for strong wind warning.

Results of the Analysis:

Criteria for Advisory: Average Wind Speed > 20km/h, Gust Wind Speed > 45km/h
Criteria for Warning: Average Wind Speed > 40km/h, Gust Wind Speed > 70km/h

(2) Approach 2: Statistical analysis using both the disaster records and AWS wind speed data. (Without considering the distance between the place where the disaster occurred and the nearest AWS)

Data used for the analysis:

- Sort the above extracted AWS wind speed data (144 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind advisory.

Period in scope of the analysis:

- January 2009 to December 2014

Method:

- Use all the disaster events on record even if the distance from the nearest AWS exceeds 10km: 703 events.
- Extract maximum average/gust wind speed observed by the AWS 48 hours prior to the occurrence of each disaster.
- Sort the above extracted AWS wind speed data (703 data) in descending order.
- Assume 50th percentile of the wind speed data as possible criteria for strong wind advisory.

Assume 95th percentile of the wind speed data as possible criteria for strong wind warning.

Results of the Analysis:

Criteria for Advisory: Average Wind Speed > 15km/h, Gust Wind Speed > 40km/h
Criteria for Warning: Average Wind Speed > 35km/h, Gust Wind Speed > 75km/h

(3) Approach 3: Statistical analysis using AWS wind speed data. (In consequence of discussion with DOM, sort all the hourly wind speed data in descending order for each AWS station. Assume the averaged 99th/95th percentiles of the wind speed data as possible criteria for strong wind warning/advisory.)

Data used for the analysis:

- AWS wind speed data (hourly, average/gust wind speed) at selected twenty (20) stations

co-located at the SYNOP stations.

Period in scope of the analysis:
- January 2009 to December 2014

Method:
- Sort all the AWS wind speed data during the period in scope of the analysis in descending order for each AWS station. (24-hr x 365-day x 6-year data)
- Extract 95th percentile of the wind speed data for each AWS station.
- Extract 99th percentile of the wind speed data for each AWS station.
  * In case AWS wind speed data is missing (-999) or below 1m/s, those data are not included in the statistical analysis.
- Assume the nationwide average of the 95th percentiles as possible criteria for strong wind advisory.
  Assume the nationwide average of the 99th percentiles as possible criteria for strong wind warning.

Results of the Analysis:
Criteria for Advisory: Average Wind Speed > 20km/h, Gust Wind Speed > 35km/h
Criteria for Warning: Average Wind Speed > 25km/h, Gust Wind Speed > 45km/h

Prospective Warning Criteria (Strong Wind)

	Existing Criteria	Approach No.1 Criteria (Disaster Event Analysis)	Approach No.2 Criteria (Disaster Event Analysis)	Approach No.3 Criteria (Statistical Analysis)
Average Wind Speed	Advisory W > 30km/h (Beaufort Scale: 5)	Advisory W > 20km/h (Beaufort Scale: 4)	Advisory R > 15km/h (Beaufort Scale: 3)	Advisory W > 20km/h (Beaufort Scale: 4)
	Warning W > 50km/h (Beaufort Scale: 9)	Warning W > 40km/h (Beaufort Scale: 8)	Warning R > 35km/h (Beaufort Scale: 7)	Warning W > 25km/h (Beaufort Scale: 5)
Gusting Wind Speed	Advisory W > 60km/h (Beaufort Scale: 11)	Advisory W > 45km/h (Beaufort Scale: 9)	Advisory R > 40km/h (Beaufort Scale: 8)	Advisory W > 35km/h (Beaufort Scale: 7)
	Warning W > 70km/h (Beaufort Scale: 0)	Warning W > 70km/h (Beaufort Scale: 0)	Warning R > 75km/h (Beaufort Scale: 7)	Warning W > 45km/h (Beaufort Scale: 6)

Newly advisory criteria for lightning has been set.

(1) Approach 1: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (Assume the averaged CAPE and SSI data as possible criteria for lightning advisory at Dry Zone, Wet + Intermediate Zone and entire country.)

Indicators used:
CAPE and SSI*
*SSI: Showalter stability index
$SSI = T_{500} - T_L$
T_{500}: the temperature (°C) at 500 hPa
T_L: the temperature (°C) of a parcel lifted from 850 to 500 mb; dry-adiabatically to saturation and moist-adiabatically above that.
*By using the correspondence table (TL_table.xlsx) about temperature (T850) and humidity (RH850) at 850hPa and TL at 500hPa, adequateness of SSI was also confirmed.

(References)

Rough indication of atmospheric instability	CAPE	SSI
Stable	< 0	> 0
Weak instability (Chance of thunderstorm)	0 – 1000	0 – -3
Moderate instability (Chance of severe thunderstorm)	1000 – 2500	-3 – -6
Strong instability (Chance of severe thunderstorm)	2500 – 3500	-6 – -9
Extreme instability (Chance of severe thunderstorm)	> 3500	< -9

Source: Japan Meteorological Agency

Data used for the analysis:
- CAPE extracted from the GFS* (lifted from the ground)
- SSI derived from the GFS* (calculated by using T850, T500 and RH850)

*GFS: 0.5 degree grid, 6 hourly initial value, Re-analyzed data
(https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-forcast-system-gfs)
- Lightning observation data from the ROB at the selected twenty (20) SYNOP stations

Period in Scope of the Analysis:
January 2015 to December 2016

Method:
- Select the nearest GFS GPV grids to represent each selected SYNOP station.
- Extract CAPEs and calculate SSIs from the GFS GPV at the time of lightning observation or at the closest time before lightning observation for each SYNOP station.
- Calculate the average of the above extracted CAPEs and calculated SSIs for each SYNOP station.
- Classify the SYNOP stations into two climate zones: Dry Zone and Wet + Intermediate Zone.
- Assume the area-averaged CAPE and SSI for the two climate zones and whole country as possible criteria for lightning advisory.

Results of the Analysis:
Criteria for Dry Zone: CAPE > 1300, SSI < -0.8
Criteria for Wet + Intermediate Zone: CAPE > 1000, SSI < -1.0
Criteria for Whole Country: CAPE > 1200, SSI < -0.9

(2) Approach 2: Statistical analysis using lightning observation data at SYNOP station and atmospheric instability data (CAPE and SSI) calculated from GFS. (In consequence of discussion with DOM, sort all CAPE and SSI data in descending order for each SYNOP station. Assume the averaged 99th percentiles of the CAPE and SSI data as possible criteria for lightning advisory.

-The reason for using 99th percentile of CAPE and SSI-
If 100th percentile (largest value) is used, lightning advisory might be hardly issued. As the first stage for operating new lightning advisory, 99th percentile (generally representing extreme value) was adopted.
It is necessary for DOM to accumulate lightning events for a few years and to verify most suitable percentile in the future. (e.g. 95th percentile would be better than 99th.)

Indicators used:
CAPE and SSI

Data used for the analysis:
- CAPE extracted from the GFS (lifted from the ground)

- SSI derived from the GFS (calculated by using T850, T500 and RH850 extracted from the GFS)

Period in Scope of the Analysis:
January 2015 to December 2016

Method:
- Select the nearest GFS GPV grids to represent each selected SYNOP station.
- Sort all the 6 hourly CAPEs and SSIs in descending order for each SYNOP station.
- Extract the 99th percentile of the CAPE and SSI for each SYNOP station.
* In case CAPE or SSI data are missing (-9999) in the GFS GPV, those data are not included in the statistical analysis.
- Assume the area-averaged CAPE and SSI for the two climate zones and whole country as possible criteria for lightning advisory.

Results of the Analysis:
Criteria for Dry Zone: CAPE > 2500, SSI < -3.5
Criteria for Wet + Intermediate Zone: CAPE > 2000, SSI < -3.5
Criteria for Whole Country: CAPE > 2300, SSI < -3.5

Prospective Advisory Criteria (Lightning)

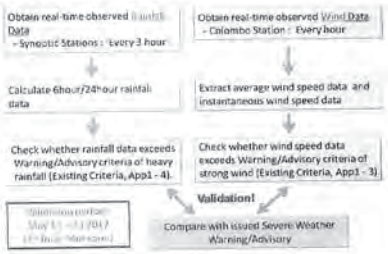
Climatic Zone	Approach No.1 Criteria (Lightning Event Analysis)	Approach No.2 Criteria (Statistical Analysis)
Wet Zone + Intermediate Zone	Advisory CAPE > 1000 & SSI < -1.0	Advisory CAPE > 2000 & SSI < -3.5
Dry Zone	Advisory CAPE > 1300 & SSI < -0.8	Advisory CAPE > 2500 & SSI < -3.5
Whole Country	Advisory CAPE > 1200 & SSI < -0.9	Advisory CAPE > 2300 & SSI < -3.5

Internal operation of revised warning criteria of heavy rain and strong wind have been conducted in the period of rainy season (1st inter-monsoon season, 2017).

Procedure of verification :

Every 3 hourly rainfall data observed at the synoptic stations have been used for verifying Heavy Rainfall Warning/Advisory. Every hourly wind data observed at Colombo station have been used for verifying Strong Wind Warning/Advisory.

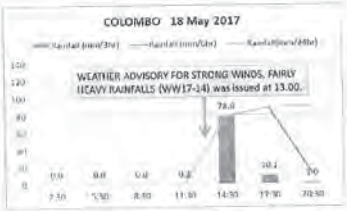
Criteria of Heavy Rainfall and Strong Wind Warning/Advisory have been verified when Severe Weather Warning/Advisory was issued.



Validation result for prospective W/A criteria of heavy rainfall :

Weather advisory for heavy rainfall was issued at 18th May, 2017 13:00.

→Criteria of approaches 3 and 4 satisfied the conditions for issuing advisory at 14:30.

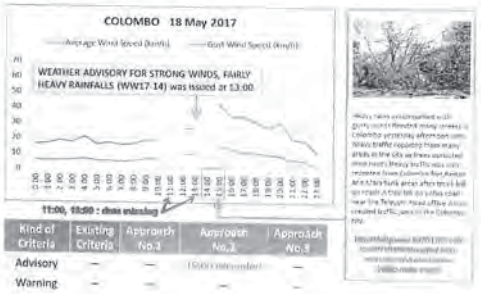


Kind of Criteria	Existing Criteria	Approach No.1	Approach No.2	Approach No.3	Approach No.4
Advisory	—	—	—	14:30 exceeded	14:30 exceeded
Warning	—	—	—	17:30 exceeded	—

Validation result for prospective W/A criteria of strong wind :

Weather advisory for strong wind was issued at 18th May, 2017 13:00.

→Criteria of approach 2 satisfied the conditions for issuing advisory at 15:00.

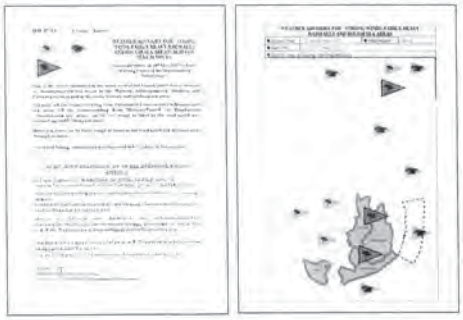


Kind of Criteria	Existing Criteria	Approach No.1	Approach No.2	Approach No.3	Approach No.4
Advisory	—	—	—	15:00 exceeded	—
Warning	—	—	—	—	—

The advisory/warning signs (Heavy Rain, Lightning, Strong Wind, Cyclone & Tsunami) have been improved in compliance with the universal design and which are comprehensible for anyone.

The advisory/warning bulletin have been improved from TEXT product to VISUAL product.

Map information of advisory/warning issued area has been added in the 2nd page.



Annex 3-5

Output 5 Actual Activities done under the Project

Table: Actual Activities done under the Project

Outputs and Activates of the PDM	Actual Activities done under the Project
Outputs 5 The method of dissemination and contents of meteorological information are improved. Activities 5.1 Review the contents of current meteorological information and identify the issues to be improved. 5.2 Improve the contents of meteorological information. 5.3 Review the timing of information dissemination to ships and fleet. 5.4 Improve the contents of Website. 5.5 Prepare smartphone compatible website.	<Identification of the Contents of Meteorological Information and the Current Issues> ■ Through several discussions with the DOM and the Baseline Study, the current issues indicated below to be improved upon were identified. ▫ There were many weather information by letters. ▫ Weather information visualized by graph etc. was small. ▫ The existing DOM Website was displayed with mixed English, Sinhala, and Tamil languages. ▫ The existing DOM Website was incompatible with various internet terminals (PC, smart phone, tablet, etc.). ▫ Templates could not be changed on the existing DOM Website. ▫ There was no information on weather educational materials. ■ Baseline Survey Report was prepared and submitted to the JICA and the DOM. <Improvement of the Contents of Meteorological Information> ■ As a result of the discussions with the DOM, the weather information of the new DOM Website was developed mainly by improving the following items. ▫ Reduction of character information ▫ Warning alert placed on top page ▫ Click button to important information displayed on top page ▫ Provision of visualized information with graphs etc. ▫ Display in English, Sinhala, Tamil ▫ Easy weather information upload ▫ Posting commentary on simple weather by image ▫ Posting weather satellite images ▫ Enabling the publication of meteorological radar images at the time the meteorological radar observation network is completed ▫ Posting information for educational materials (disaster awareness materials) <Review the timing of information dissemination> ■ Discussions on timing of issuance of meteorological Information for ships and fleet were held. ■ After the discussions with the DOM, it was decided to post meteorological Information for ships and fleet on the new DOM Web

5.6 Prepare educational materials (disaster awareness materials) for the weather services.	site. ■ Meteorological Information for ships and fleet for timely provision to the users was posted on the new DOM Web site. <Improve the Content of the DOM Web site> <Preparation and usage monitoring of a new DOM Web site> <Preparation of a new DOM Web site compatible with smartphones> ✧ Development of a new DOM Website compatible with various internet terminals ■ Brainstorming was conducted to consider the best way to develop a new DOM Website. ■ Preparation of a new template for the DOM new DOM Website was completed. ■ After discussions with the DOM, the page layout and design of the new DOM Website was confirmed. ■ Consultation with the Information and Communication Technology Agency of Sri Lanka (ICT), which operates and maintains all the Websites of the government organizations of Sri Lanka, Joomla 3.4 which is the most suitable CMS (Content Management System) was adopted for realizing compatibility with various Internet terminals (PC, smart phone, tablet, etc.) and easy update. ■ In order to develop a new DOM Website that adopted Joomla 3.4, the selected local contractor was ordered. ■ The DOM applied for updating of a new DOM Website to ICTA. ■ The ICTA reviewed the technical regulations and updated the existing website of the new DOM Website. ■ Confirmation of that the new template has appropriate compatibility was made by a smartphone. ■ Improvement/optimization for the Contents created by the DOM on the new DOM Website to be appropriately displayed on various internet terminals (Windows, Mac OS, iPhone, iPad, Android, etc.) was carried out. ■ An external site "Save Yourself" that can display and download animated cartoons on various Internet terminals was established. ■ A link banner was placed on the front page of the new DOM Website to access the animated cartoon site named "Save Yourself". ■ Japanese meteorological satellite (Himawari 8) was posted on the new DOM Website and a meteorological radar image was located on the new DOM Website. <Preparation of educational materials for weather information dissemination >

Activity 5-2

	<Monitoring status of utilization of educational materials > ✧ Educational materials for weather information dissemination: Animated cartoon for awareness program on disaster risk reduction and DOM mascot ■ Discussions with DOM have been conducted for creating public relations materials such as animated cartoon, educational materials, DOM mascot, DOM website and others which are contributing to raise public awareness on disaster risk reduction. ■ It was decided to use a peacock as design of DOM mascot to be utilized in awareness program on disaster risk reduction. ■ Through discussion with DOM, it was decided that the episodes of animated cartoon for awareness program on disaster risk reduction are Climate of Sri Lanka, Thunderstorm and Lightning, and Heavy Rain and Disaster. ■ DOM mascot to be utilized in awareness program on disaster risk reduction was designed. ■ Thirty thousand (30,000) of DOM rubber mascots, which are free of formaldehyde and cadmium, were produced for distributing purposes to students. ■ Five characters of the animated cartoon for awareness program on disaster risk reduction were designed. ■ Names of the five characters of the animated cartoon were decided, which are understandable both in Sinhalese and Tamil, as well as familiar in Sri Lanka. ■ Story plots and scripts for the three episodes of the animated cartoon for awareness program on disaster risk reduction were prepared. ■ In accordance with the scripts, storyboards for the three episodes of the animated cartoon for awareness program on disaster risk reduction were prepared. ■ In accordance with the storyboards, animated images of three episodes, Climate of Sri Lanka, Thunderstorm and Lightning, and Heavy Rain and Disasters, were made. ■ Voice providers for the five animation characters in each language, English, Sinhalese or Tamil, were selected from among DOM staff through a voice audition. ■ Voice recording for the five characters in each language, English, Sinhalese and Tamil, was implemented. ■ By merging animated images, recorded voices and background music, animated cartoon consisting of the three episodes, Climate of Sri Lanka, Thunderstorm and Lightning, and Heavy Rain and Disaster, for awareness

Activity 5-3

	program on disaster risk reduction was completed. ✧ Open Class ■ Open classes using animated cartoon consisting of the three episodes for awareness program on disaster risk reduction were implemented fourteen (14) times in Colombo, Kalutara and Nuwara Eliya districts. ■ Comprehension tests were conducted for 2,922 students/participants just before/after showing the animated cartoon for awareness program on disaster risk reduction to understand their understanding. ■ DOM rubber mascots, on the back side of which the new DOM Website address was printed, have been distributed to the students who attended the open classes. ■ Implementation of open classes was confirmed to be effective, considering that average score of comprehension test just before/after showing the animated cartoon is fifty two (52) and eighty (80) respectively. ■ Open classes organized by the DOM are continuously implemented. ✧ Educational materials for weather information dissemination: Beaufort Wind Scale ■ Laminated sheets of Beaufort Wind Scale on Land and at Sea in three languages, English, Sinhalese and Tamil, were made. ■ The laminated sheets of Beaufort Wind Scale were distributed to visitors to the DOM such as school teachers, government officials, military personnel in charge of meteorological services, staff of overseas weather-related organizations and others.

Activity 5-4

Details of the PDM Outputs under the Project

■ Output 5: The method of dissemination and contents of meteorological information are improved.

<Development of a new DOM Website compatible with various Internet Terminals>

In order to overcome the issues clarified in the Baseline Survey, a new DOM Website that can be compatible with various Internet terminals (PC, smart phone, tablet etc.) and easily update, which satisfy each item listed below was developed under the Project.

- Reduction of character information
- Warning alert placed on top page
- Click button to important information displayed on top page
- Provision of visualized information with graphs etc.
- Display in English, Sinhala, Tamil
- Easy weather information upload
- Posting commentary on simple weather by image
- Posting weather satellite images
- Enabling the publication of meteorological radar images at the time the meteorological radar observation network is completed
- Posting information for educational materials (disaster awareness materials)

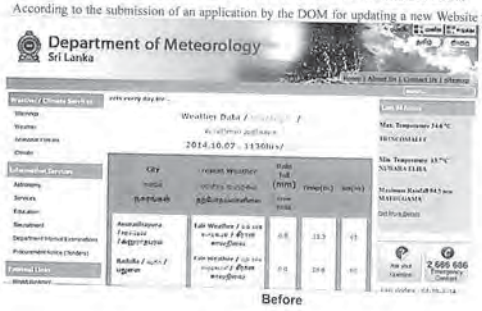
In addition, the basic policies of designing a new DOM Website are as follows.

- As the design goal of a new DOM Website, Keep It Simple (KIS) was adopted.
- Setting up a reasonable blank space (white space) between lines, letters, elements, etc., and made it a website that reduces the burden of reading by the user was considered.
- A website that effectively utilized visual communication (layout (format, composition, grid), typography (type selection, character handling), color and texture, animation etc.) was made.
- As soon as a user sees the page, he/she makes it a structure and design that can understand the contents and functions of the page.
- A clear link to move to another page was made.

Activity 5-5

- Images were easier to see than text, making bold more prominent than plain text.

The images of the top page of the existing and new DOM websites are attached below. According to the submission of an application by the DOM for updating a new Website to



Before

After

Activity 5-6

the ICTA (Information and Communication Technology Agency of Sri Lanka), the technical review by the ICTA was carried out.

Since the renewal was approved through technical review by the ICTA, the existing DOM Website was replaced with a new Website on November 25, 2016.

The operation test and adjustment were conducted between November 25 and December 31, 2016, and January 01, 2017 was set as the date of launch of the new DOM Website.

The results of the investigation on the number of accesses of the new DOM Website are as follows.

- Average Number of Accesses per day during Baseline Survey: 2,000
- Target of Average Daily Access of the new DOM Website (Indicator of PDM Output: 30% up): 2,600
- Average Daily Access of the new DOM Website between January and June 2017: 2,714 (36.8% up)

As a result, the indicator of PDM Output which is "access number increased by 30% or more" was satisfied (Average Daily Access: 2,736 / Target of Average Daily Access: 2,600 = 1.368 = 36.8%)

Table 24: Number of accesses of new DOM website

Month		Total Monthly Access		Days		Average number of Accesses/day
January 2017	:	63,355	/	31	=	2,044
February 2017	:	49,379	/	28	=	1,764
March 2017	:	53,052	/	31	=	1,711
April 2017	:	47,386	/	30	=	1,580
May 2017	:	193,882	/	31	=	6,254
June 2017	:	88,156	/	30	=	2,939
July 2017	:		/	31	=	
	Total :	495,210	/	181	=	2,736

Activity 5-7

Figure: Status of the Number of new DOM Website

<Educational materials for weather information dissemination: Animated cartoon for awareness program on disaster risk reduction and DOM mascot>

Production of 3 episodes of disaster awareness cartoons (EP1: Climate of Sri Lanka, EP2: Thunderstorm and Lightning and EP3: Heavy Rain and Disaster) in English, Sinhala and Tamil have been completed (voice of 5 characters in the cartoons by DOM personnel) was completed in accordance the Flow of Animation Production attached right side.

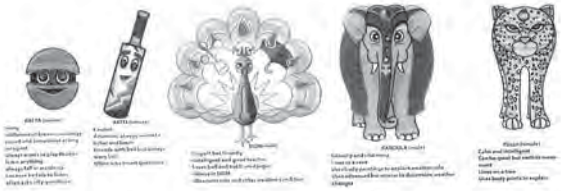
Flow of Animation Production

Writing story plot
↓
Character design
↓
Writing script
↓
Production of storyboard
↓
Production of animation
↓
Voice audition
↓
Voice recording
↓
Background music & sound effect
↓
Final output

Storyboard

Activity 5-8

Voice providers for the five animation characters in each language, English, Sinhalese or Tamil, were selected from among DOM staff through a voice audition and voice recording was implemented.



Production of the DOM mascot for the students who joined the Open Class made of rubber which is cadmium and formaldehyde free material was completed.

<A link banner for accessing the animated cartoon site named "Save Yourself">

A link banner was placed on the front page of the new DOM Website to access the animated cartoon site named "Save Yourself"

Activity 5-9

<Open Class>

Open classes using animated cartoon consisting of the three episodes for awareness program on disaster risk reduction were implemented fourteen (14) times in Colombo, Kalutara and Nuwara Eliya districts. Comprehension tests were conducted for 2,922 students/participants just before/after showing the animated cartoon for awareness program on disaster risk reduction to understand their understanding. Implementation of open classes was confirmed to be effective, considering that average score of comprehension test just before/after showing the animated cartoon is fifty two (52) and eighty (80) respectively.

Table 25: Records of Open Class

No.	Date & Time	Venue	Name of School	Shown Version of the Cartoon	Number of Sessions	Grade	Number of Students/ Participants	Average Score	
								Pre Test	Post Test
1	March 08, 2017 14:00-15:00	DOM Auditorium	Siridhamma College, Galle	Sinhala	1	8	209	52	81
2	March 10, 2017 10:00-11:00	Ananda Girl's College, Colombo	Ananda Girl's College, Colombo	Sinhala	1	8	217	60	92
3	March 30, 2017 09:00-10:30	National Youth Corps, Walapana, Nuwara Eliya	National Youth Corps, Walapana, Nuwara Eliya	Sinhala	1	A-D	123	55	91
4	March 30, 2017 11:30-13:00	Nandarama College, Nuwara Eliya	Nandarama College, Nuwara Eliya	Sinhala	1	6-11	121	47	74
5	March 31, 2017 09:00-10:30	T.B.M. Herath Secondary College, Nuwara Eliya	T.B.M. Herath Secondary College, Nuwara Eliya	Sinhala	1	6-11	306	46	77
6	March 31, 2017	Kalagamwatta Navodya	Kalagamwatta Navodya	Sinhala	1	6-12	246	43	68

	12:00-13:30	School, C.S, Nuwara Eliya	School, C.S, Nuwara Eliya						
7	March 31, 2017 15:30-17:30	Community Centre, Kandayaya, Nuwara Eliya.	(For general public)	Sinhala	1	–	75	–	–
8	April 26, 2017 10:00-11:30	Princess of Wales girls school, Colombo	Princess of Wales girls school, Colombo	Sinhala	1	8-9	440	62	89
9	May 19, 2017 10:45-12:10	Walagedara Navoya School, Mathugama, Kalutara	Walagedara Navoya School, Mathugama, Kalutara	Sinhala	1	9-11	258	68	93
10	May 23, 2017 09:40-11:10	Holy Trinity Central College, Nuwara Eliya	Holy Trinity Central College, Nuwara Eliya	Tamil	1	8-13	487	51	80
11	May 23, 2017 15:25-16:35	Maskeliya Plantation P.L.C. Troup Estate Dispensary & Maternity Ward, Talawakelle, Nuwara Eliya	"Barathy Maha Vithyalayan, Talawakelle, Nuwara Eliya	Tamil	1	6, 8-13	51	47	71
12	2 May 23, 2017 17:15-18:00	Talawakelle Tea Estate P.L.C. Holyrood Estate Training Centre	(For tea plantation workers and their children)"	Tamil	1	–	64	–	–
13	May 24, 2017 09:20-11:00	St. Xiver's College, Nuwara Eliya	(For tea plantation workers)	Tamil	1	6-13	255	37	60
14	May 24, 2017 11:20-12:20	St. Xiver's College, Nuwara Eliya	St. Xiver's College, Nuwara Eliya	Sinhala	1	1-11	70	–	–
			Total				2,922	52	80

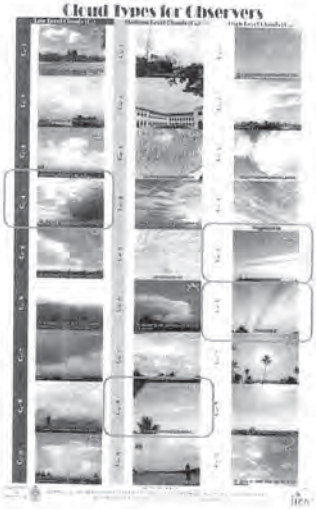
<Educational materials for weather information dissemination: Beaufort Wind Scale>

Laminated sheets of Beaufort Wind Scale on Land and at Sea in three languages, English, Sinhalese and Tamil, were made. The laminated sheets of Beaufort Wind Scale were distributed to visitors to the DOM such as school teachers, government officials, military personnel in charge of meteorological services, staff of overseas weather-related organizations and others.

<Cloud Types for Observers in Sri Lanka>

The DOM original "Cloud Types for Observers" was prepared by the Consultant Team. However the DOM original "Cloud Types for Observers" with 27 (the required number of total cloud pictures) cloud pictures was not yet completed since 4 types of the cloud pictures in red frames on "Cloud Types for Observers" attached the right side unfortunately were not taken in Sri Lanka by the Consultant Team.

This is to request the DOM to take the remaining 4 types of the cloud pictures and replace them with original pictures to be taken by the DOM for the completion.



Annex 4-1

Recommendations towards the Achievement of the Overall Goal

The Overall Goal of the Project is for the "weather information disseminated from the DOM is well utilized by the public and the disaster related organizations". For that purpose, it is important to issue highly accurate weather forecasts and warnings to contribute to mitigating the damage caused by natural disasters, and as a result, it is necessary to improve the public trust with the DOM's weather information.

Figure: Issuance of Meteorological Forecasts & Warnings and Collaboration with Disaster Prevention related Organizations to be Strengthened

In order to alleviate damage from gusts, floods and landslides caused by heavy rain in Sri Lanka, it is important that the DOM grasps accurately the current weather conditions through observation and issues highly accurate weather forecasts and warnings. Furthermore, it is indispensable for each disaster prevention related organization to cooperate with each other and to fulfill their own services. In particular, the DOM has the role of the preparation of accurate forecasts/warnings and promptly disseminating them to each organization, and the information from the DOM is a trigger for the initial activity of each disaster prevention related organization. For that reason, further improvement of the weather forecasts/warnings of quantitatively (= issuance frequency) and qualitatively (= accuracy) is strongly required in order to further strengthen the DOM's meteorological observation system, reliably send observation data to the National Weather Center (NWC) in the DOM Head Office, analyze and process the information and reflect these observation data in the forecasts.

In order to further enhance the benefits of the Project, recommendations towards the achievement of the Overall Goal of the Project are as follows.

() Manpower Development

- The development of more qualified technical personnel through continuous training and other related manpower development programs; and,
- The conduct of timely research to increase the level of understanding/knowledge about meteorological disasters.

2) Natural Disaster Prevention and Management

- The creation of effective communication and collaboration with the various government agencies, NGOs, and international institutions for better coordination of natural disaster prevention and management;
- The formulation of effective and consistent disaster prevention schemes through different stages, from Weather Forecasting, Warning Announcement, Disaster Occurrence, Information Dissemination, all the way to Evacuation Stage;
- Implement and ensure wider dissemination of knowledge and information on disaster-prevention activities to all sectors including government disaster management agencies, the private sector, and the population at risk;
- Setting up of redundancies in the announcement of warnings and other information dissemination to ensure reaching out to the general populace;
- Continuing education to the general public, especially the population at risk, through the Local Government Units (LGUs) in coordination with various related disaster management agencies on effective natural disaster prevention and management;
- Further strengthening of a cooperative structure among the mass media (TV, radio, newspaper), the Prime Minister's Office, Ministry of Disaster Management, Ministry of Irrigation & Water Resources Management, Ministry of Transport, Ministry of Agriculture, Civil Aviation Authority, Ministry of Health & Indigenous Medicine, Ministry of Fisheries and Aquatic Resource Development, Ministry of Highways, Ports & Shipping, Department of Police, Fire Station, other government-affiliated organizations, Sri Lanka Red Crescent Society, etc.; and,
- Furtherance of utilization of the meteorological information/data and forecasts/warnings by the mass media (TV, radio, newspaper), the Prime Minister's Office, Ministry of Disaster Management, Ministry of Irrigation & Water Resources Management, Ministry of Transport, Ministry of Agriculture, Civil Aviation Authority, Ministry of Health & Indigenous Medicine, Ministry of Fisheries and Aquatic Resource Development, Ministry of Highways, Ports & Shipping, Department of Police, Fire Station, other government-affiliated organizations, Sri Lanka Red Crescent Society, etc.

Recommendations for further contribution for mitigating the damage caused by natural disasters by the DOM

Recommendations of each Output of PDM for further contribution for mitigating the damage caused by natural disasters by the DOM are described in the following table.

Table : Recommendations towards the Achievement of the Overall Goal

Output of PDM	Recommendations
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	· To conduct a technical training for the DOM staff in charge of the maintenance and inspection of the meteorological observation instruments using knowledge gained from this Project.
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	· To encourage and continue the maintenance of the observation fields (prevention of animal intrusion, etc.) and the environmental improvement of the observation rooms (installing an air conditioner). · In order to enhance and guarantee the continuous operation of the automatic weather observation systems (AWS) and to ensure the technical training of the electrical engineering staff, the establishment of appropriate measures against system failure, scheduled replacement of parts and a fully documented maintenance system with proper document control is indispensable. · To conduct technical training for new staff and periodic inspection by the manufacturing company for the stable operation of the GTS/Message Switching System (MSS).
3. Capacity of weather forecasting is improved using obtained meteorological data.	· Continuous recruitment of human resources for roles in forecast operation for the next generation. Simultaneously, the development of excellent weather forecasters need to be sustained by conducting forecast trainings within the DOM, encouraging staff to attend a training program abroad and supporting staff to earn Masters or Doctoral degrees. · To conduct accurate evaluation of the Local Numerical Weather Prediction WRF model aimed at actual operation to put the Weather Guidance using the data of the WRF model/the Global Numerical Weather Prediction Model to practical use. · To accumulate the grid point values (GPV) after the calculation of the WRF model every day for the evaluation and the improvement of the model. · Continuous improvement of overall forecasting works taking in

	the knowledge and data of meteorology. · In order to understand real time local weather conditions across the country and utilize them for disaster prevention operations, it is imperative to transmit observation data of all the AWSs to the DOM Head Office without any delay for accurate evaluation of the Numerical Weather Prediction and Weather Guidance.
4. Warning criteria is elaborated.	· To create an updated, accurate and consistent database of meteorological disasters (disaster occurrence time, disaster location, damage situation, weather condition, weather information and transmission condition). · To conduct further research to increase the level of understanding/knowledge about meteorological disasters and its mechanisms along with other related meteorological phenomena. · To improve forecasting works relevant to meteorological disasters through the implementation of the above recommendations at the same time continually develop human resources capable of doing the verification and review of warning criteria.
5. The method of dissemination and contents of meteorological information are improved.	· In order to reduce natural disaster risk, it is important to improve the cooperation with organizations/agencies related to disaster management and mass media as the means for transmission of disaster information. · To conduct continuous public awareness activities about disaster prevention. · In order for the public to find weather information easier, it is necessary to improve the DOM's Website continuously. · To develop and recruit the human resources needed to implement the above recommendations. · To continuously conduct Open Class both in Colombo city and in local regions. · To continuously develop human resources within the DOM who can conduct Open Class. · To exchange ideas and opinions on a regular basis with stakeholders on the method of dissemination and the contents of meteorological information through the Monsoon Forum conducted biannually by the DOM, and try to feed back the results into the DOM's activity and products for further improvements. · To continuously inform availability of the renewed DOM website through the Monsoon Forum and Open Class. · To produce "Weather Summary on Severe Weather Disaster (tentative title)" immediately after disaster occurrence (within one day after the disaster), and distribute it to the relevant organizations and be on the DOM website.

Annex 4-2

Recommendations towards the Achievement of the Overall Goal (Long-term Expert)

1) Modernization of surface meteorology observation

- The current parallel operation of the manual observation and the automatic observation at the DOM regional offices have been a large burden regarding budget and human resources.
- Transformation to automatic observation using the current AWS should be planned.
- Firstly, several test bed stations of automatic observation should be started to make the total plan of the transformation.
- Training of the observers on full automatic observation of the AWS should be implemented in parallel.
- After establishing the technology of full automatic observation, the full automatic observation will be started at the all sites.

2) Renovation of the organization of DOM

- In accordance with the modernization of the surface meteorological observation and installation of the dual-polarization Doppler radar systems, the renovation of the organization of DOM and reeducation and relocation of human resources should be planned.
- It should be discussed that the role of the regional offices of DOM could be shifted from the current observation points to the dissemination bases of weather information for the local citizen.

3) Capacity development

- DOM has been making efforts to make capacity development through the inhouse training, the JICA group training, and graduate programs in foreign countries. Such capacity developments should be continued corresponding to abilities of the DOM staff members.
- Research activities and inhouse seminars concerning meteorological analysis for disaster events should be made in order to enhance their knowledge on the latest meteorological knowledge.

4) Establishment of the system of rules

- Acts covering the entire weather services of DOM, rules, guidelines and manuals for all the duties on the weather services of DOM should be prepared in order to authorize and standardize the weather services of DOM.

Recommendations to the DOM for further contribution to mitigate the damage caused by natural disasters

(Long-term Expert)

Table Recommendations towards the Achievements of the Overall Goal

Output of PDM	Recommendations
1. Capacity on maintenance and calibration of meteorological observation equipment is improved.	· To continue the new instrument calibration scheme established in the project and ensure the traceability of the meteorological instruments concerning pressure and temperature through the constant calibration of the domestic meteorological instrument. · To continue close communication and association with the overseas Regional Instrument Center of the World Meteorological Organization (WMO), particularly with RIC-Tsukuba · Concerning instruments of humidity, wind and rainfall, to start the establishment of the traceability of instruments, installing the DOM standard instruments and calibration devices, with receiving technical supports from the RIC-Tsukuba. · To make regular calibration of the DOM standards with the RIC standards to ensure the traceability of instruments. · To connect an internet line to the instrument division of DOM to contact the RIC-Tsukuba to exchange information on the instrument traceability. · To schedule daily radiosonde observation considering the budget and human resources.
2. Transmitting and receiving capacity of various kinds of meteorological data is strengthened.	"
3. Capacity of weather forecasting is improved using obtained meteorological data.	"
4. Warning criteria is elaborated.	"
5. The method of dissemination and contents of meteorological information are improved.	"

Annex 5

Other discussions in the 4th JCC on 26th July 2017

- DOM was mentioned that the current service provider (ICTA) for website is not efficient as when there is some breakdown during the night time, there is no engineer to attend for the maintenance. Therefore DOM has to wait until next day morning if some error occurred during the night.
- Secretary asked DOM to check the possibility to change the service provider in order to get better service for DOM.
- Secretary asked DOM regarding MOU (Memorandum of Understanding) for Himawari Satellite and Ms. Anusha mentioned still there is no MOU for Himawari satellite.
- Secretary concerned about possibility to get satellite images for public people. Then Mr. Wijemmanage explained the difference between satellite image and satellite data. (Satellite image can be taken by any public person which can't be analyzed and Satellite data which is receiving through satellite data receiving system, could be analyzed based on temperature data etc.,)
- Secretary stated that Data dissemination part is most important.
- DOM mentioned that they are using Norwegian software to downsize the data which they got through WRF. Mr. Akatsu mentioned that JMA provides those data free of charge and Mr. Malith stated that JMA data has been limited to some areas and JMA grid size is 20 KM while Norwegian gird size is 8KM. Using the Norwegian software they were able to take more accurate data due to grid size is smaller.
- Secretary mentioned that media organizations must have good knowledge to present meteorological forecast to public due to awareness through the media organizations take part important role in dissemination.
- Mr. Wijemannage proposed to telecast daily weather forecast each & every channel during specific time period. So that people will not miss it as whatever the channel they are watching same time every channel telecast the weather forecast. Secretary did not much agree with that idea.
- Mr. Nuwan proposed to introduce pop-up system with different color codes and color codes will be decided based on the condition of the weather (serious/not serious).
- DOM stated that VAISALA introduced them very accurate software for lightning detection which they can use free of charge for 2 years on period. Dr. Ishihara gave some information on the world wide lightning detection system provided from a NPO group.

- Secretary mentioned that it's important to detect lightning to give prior warning but improving awareness of people to prevent such natural disasters take part more important.
- Severe drought is continuing in 15 districts from last year. Weather forecast is more important than earlier due to this kind of serious weather disasters occurring time to time.
- DOM expects there will be showers during end September or October.
- Mr. Akatsu mentioned that through it is important to forecasting weather, it will be more important to have sound knowledge on current weather situation. Secretary agreed with him.
- Secretary asked DOM to check the status about meteorological lessons in the school text books for school students with Education department, to make sure whether students having sufficient knowledge on meteorology through the education system.
- Secretary agreed with the Dr. Ishihara's recommendation to make act on meteorological services.