



**FIRST STEERING COMMITTEE MEETING (SCM 1)
MEKONG RIVER COMMISSION FLASH FLOOD GUIDANCE (MRCFFG) SYSTEM**

Pnom Penh, Cambodia

29 November–1 December 2016



FINAL REPORT

March 2017

TABLE OF CONTENTS

1. Executive Summary	1
2. Opening of the Session.....	2
3. Organization of the First Steering Committee Meeting (SCM 1).....	2
4. Proceedings of the Steering Committee Meeting 1 (SCM 1)	2
4.1 Roles and Responsibilities of the Regional Centre and Participating NMHSs	2
4.2 Individual Country Presentations	3
4.2.1 Cambodia.....	3
4.2.2 Lao PDR.....	4
4.2.3 Myanmar	5
4.2.4 Thailand.....	5
4.4 SWFDP-SEA and MRCFFGS Linkages	7
4.5 Mekong River Commission Region Flash Flood Guidance System (MRCFFGS) Training (Step 1).....	8
4.5.1 MRCFFG System Development and Theoretical Background	8
4.5.3 Advances in FFGS Functionalities	9
4.5.3 Overview of Current and Updated MRCFFG System and its Products.....	9
4.5.4 Case Studies	10
4.5.5 BSMEFFGS Verification Results.....	11
4.6 MRCFFGS Hydrometeorological Training.....	11
4.8 Project Implementation Plan	12
5. Conclusions of the Steering Committee Meeting 1.....	12
6. Closing of the Steering Committee Meeting 1	14
ANNEX I.....	15
ANNEX II.....	19
ANNEX III	23
ANNEX IV.....	25
ANNEX V.....	27
ANNEX VI.....	30
ANNEX VII.....	31
ANNEX VIII.....	32
ANNEX IX.....	33
ANNEX X.....	34
ANNEX XI.....	35

First Steering Committee Meeting 1 (SCM 1) of The Mekong River Commission Flash Flood Guidance (MRCFFG) Project

Phnom Penh, Cambodia, 29 November- 1 December 2016

1. Executive Summary



In the Southeast Asia region, flash floods account for a significant portion of the lives lost and property damages caused by flooding. Given that flash floods can occur at any time or place with disastrous results so that there is an urgent need to prioritize efforts that aim to improve early warnings capabilities of the National Meteorological and Hydrological Services. Improvements help society to cope with flash flood threats by enabling the mandated national authorities to undertake appropriate measures, thereby contributing to protecting the population at risk from the disastrous effects of

flash floods.

As part of WMO's Flood Forecasting Initiative and on the basis of a 4-party Memorandum of Understanding signed by the World Meteorological Organization (WMO); US NOAA National Weather Service (US NWS); the Hydrologic Research Center (HRC), San Diego, USA; and U.S. Agency for International Development/Office of U.S. Foreign Disaster Assistance (USAID/OFDA), the signatories have established a cooperative initiative for the Flash Flood Guidance System with Global Coverage Project. To attain global coverage, specific projects are planned and conducted on a regional basis with countries that have committed in writing to participate actively in the implementation and operation of the forecast system.

The original Mekong River Commission Flash Flood Guidance (MRCFFG) system became operational in October 2009. The countries involved in the MRCFFG project include **Cambodia, Lao PDR, Thailand, and Viet Nam**. The Mekong River Commission Regional Flood Management and Mitigation Centre (MRC RFMMC), based in Phnom Penh, Cambodia, has the responsibility of being the Regional Centre for the MRCFFG system. The system was installed at the MRC RFMMC, with the system outputs being made available to forecasters in all four countries via the internet. Every day, the MRC analyses the MRCFFG output and provides critical system products for evaluating potential flash flood threats throughout the region on their website at <http://ffw.mrcmekong.org/mrcffgs.htm>.

The original installation of the MRCFFG System pre-dates the Memorandum of Understanding (MoU) signed by the project partners, namely WMO, HRC, NOAA, and USAID/OFDA. As such, WMO had not been involved in the realization of the previous project activities. The project now is under the auspices of the 4-party partnership, and the partners in consultation with the representatives of the participating countries deemed it necessary that the system be upgraded to reflect the latest advances in product development and in the flash flood hydrometeorologist training programme to standardize and provide additional training to forecasters from the participating NMHSs. These efforts are needed to bring the MRCFFG in line with other regional FFGS projects. These new activities are specified in the Letter of Agreement, Revision 2 and 4, Work Plans III and V.

As per Letter of Agreement, Revision 2, Work Plan III, first Steering Committee Meeting (SCM1) of the MRCFFG system was held in Phnom Penh, Cambodia from 29 November to 1 December 2016 with the participation of representatives of NMHSs of Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam as well MRC, WMO and HRC. The objectives of the meeting were to: a) overview roles and responsibilities of the Regional Centre and participating NMHSs; b) become familiar with the upgraded HRCFFG System and its products; c) present case studies of past flash flood events; d) discuss ideas and possible agree on how to proceed on effective and efficient use of the MRCFFG system and its products in daily flash flood forecasts; e) enhancement of collaboration among MRC, NMHSs, and water management authorities.

2. Opening of the Session

In opening the first Steering Committee Meeting, the representatives of MRC, WMO, and HRC highlighted the importance of improving the timely delivery of flash flood information and guidance to the populations at risk and in the importance of fostering stronger partnerships among countries in the region to strengthen national capabilities to forecast and warn populations at risk from flash flooding and other hydrometeorological hazards. Although the core aspects of the project focus on the enhancement of capacities of the participating NMHSs for the issuance flash flood warnings and watches, it was highlighted that the guiding indicator for the ultimate success of the project is effective outreach to people and reducing their risk of being affected by flash floods in a disastrous way.

In his opening remarks, Mr Oudomsack Philavong, team leader at MRC, welcomed all participants and expressed his appreciations of hosting such important meeting in Phnom Penh, Cambodia. He said that MRCFFG was one of the pioneer Flash Flood Guidance System implementation and it has been used very efficiently by the MRC to provide services and products to its members states. He stated that he was very pleased to see that an upgrade of the MRCFFG system has been completed with new features to enable the participating NMHSs to issue timely and accurate flash flood warnings to save lives. He thanked all participants for attending the meeting and wished them successful meeting. He also thanked the representative of WMO for facilitating the meeting and HRC for developing and implementing the state-of-the-art-flash flood guidance system for the benefits of the people in the region. He concluded his welcome speech stressing the importance of regional cooperation in effective and efficient use of the MRCFFG system. Mr Eylon Shamir, HRC, welcomed everyone to the meeting and was pleased to see the representatives of the participating NMHSs attending the meeting. He emphasized its importance in enhancing the capacities of NMHSs of the Southeast Asian region for effective early warnings of flash floods. Mr Ayhan Sayin, WMO, recalled the objectives of the meeting and its expected results, welcomed the participants, and encouraged them to provide their active inputs into shaping this important regional Flash Flood Guidance system project. He also thanked the MRC for all its efforts including hosting the meeting, thereby helping to make a positive atmosphere that would undoubtedly contribute favorably to the success of the meeting.

3. Organization of the First Steering Committee Meeting (SCM 1)

The First Steering Committee Meeting of the MRCFFG System was held in Phnom Penh, Cambodia from 29th November to 1st December 2016, and was attended by the representatives of NMHSs from Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam. Other participants included representatives from WMO, MRC, HRC, and National MRC committee of Cambodia. The list of participants is provided in Annex I, while the annotated SCM 1 agenda is given in Annex II.

4. Proceedings of the Steering Committee Meeting 1 (SCM 1)

4.1 Roles and Responsibilities of the Regional Centre and Participating NMHSs

Mr Ayhan Sayin (WMO) provided an overview of the roles and responsibilities of the Regional Centre as being, inter alia: to assist all involved project partners including the HRC for the development and implementation of the MRCFFG system; to have sufficient infrastructure, including high speed internet access, WMO Global Telecommunication System (GTS) connection, and human resources to operate the system and provide services to the participating countries; to participate in the flash flood hydrometeorological training programme, including operational training at HRC, San Diego, CA, USA; to lead and evaluate flash flood potentials using MRCFFG system products and other available tools; to evaluate the MRCFFG system products from the regional perspective and verify the system products and warnings; to assist the participating NMHSs to issue flash flood watches and warnings; and to provide routinely training in collaboration with WMO to the forecasters from participating NMHSs.

He also stated that roles and responsibilities of the participating NMHSs are to:

- have good cooperation, collaboration, and communication with the Regional Centre (RC) for the implementation and operation of the MRCFFG system;
- provide historical and in-situ local data to the FFG system developer through the RC as specified in Annex IV and V;
- ensure use of the MRCFFG system and its products as part of daily operational flash flood forecasting and warning;
- prepare and issue flash flood warnings and alerts to the public and national agencies including Emergency Management Authorities;
- participate in the Flash Flood Hydrometeorological Training Programme steps 1-5;
- provide training (Steps 4 and 5) on the MRCFFG approaches and products to their local duty/shift forecasters to make best use of the system to forecast hydrometeorological hazards;
- have close cooperation and collaboration with the national Disaster Management Authorities and to provide them with flash flood forecasts and warnings so that appropriate actions can be taken; and
- prepare case studies for local flash flood events and conduct forecast verification studies and distribute their results to the RC and HRC.

4.2 Individual Country Presentations

Experts from each country provided in-depth presentations on the current situation of their national services related to hydrometeorological forecasting capabilities, practices and development plans. The presentations are available on the WMO website (www.wmo.int)¹. The presentations revealed the similarities and differences that exist among the countries regarding their capabilities to deliver weather and flood forecasting and early warnings, especially for those pertaining to flash floods. Two countries, namely Thailand and Viet Nam, indicated that they have dedicated flash flood forecasting systems apart from the MRCFFG system. Cambodia and Lao PDR do not presently have their own dedicated flash flood systems.

4.2.1 Cambodia

The expert from Cambodia, Mr Oum Ryna, provided an overview of the hydrometeorological services, including hydrometeorological observation network, Numerical Weather Prediction Models,

¹ The link to the material is <http://www.wmo.int/ffgs>

floods/flash floods forecasts and riverine monitoring, hydrological modelling and research, and forecasting of water level in pilot regions. He stated that weather observation network and forecast tools consist of 35 Automatic Weather Stations (AWS), manual weather stations, rain gauges, one S-Band weather RADAR, GTS connection, high performance servers, and a HIMAWARI weather satellite data reception and visualization station; while the hydrological observation network consists of 12 stations, 8 of which have been installed as part of the Mekong-HYCOS project. He articulated that the Ministry of Water Resources and Meteorology (MWRM) provides climate data and information; Nowcasting; three-day, one-week, and seasonal forecasts; and severe weather warnings as a public weather service. He further articulated that Cambodia faces Tropical Storms and severe thunderstorms that produce heavy rainfall, resulting in riverine flooding and flash floods. He showed the hydrometeorological warning preparation and dissemination process flowchart for severe weather and hydrological warnings including floods and flash flood warnings that are prepared by the MWRM. Such products are disseminated to local authorities, the National Committee for Disaster Management, the Ministries of Defense and Interior, the Red Cross, and media through fax, phone, email, and public web portal. He further showed the flood warning system for the Mekong River basin and explained how the communities are informed through sirens. He concluded his presentation specifying strengths, weaknesses, and needs. He noted that recently substantial capacity development activities have taken place, with increased cooperation and collaborations among national institutions, including NGOs. He also noted that they were lacking sufficient human resources at the provincial level, and there was a need to extend the observational network.

During the facilitated discussions, he said that forecasters at the Department of Meteorology and Hydrology do not work 24/7 except during emergency situations; unfortunately they are not able to access the MRCFFG system not use its products in issuance of flash flood warnings; and there are currently no trained forecasters who could use the MRCFFG system even if they were able to access it; and that one hydrologist has attended the operational training at HRC, but he is currently not working at the forecasts office that is responsible to prepare flash flood warnings.

4.2.2 Lao PDR

The expert from Lao PDR, Mr Prasith Deemaneevong, provided an overview of the Department of Meteorology and Hydrology (DMH) focusing on use of the MRCFFG products in issuance of flash flood warnings and lessons learnt. First of all, he showed the organization chart of DMH and explained that there were two main administrative entities - a headquarters and provincial offices. Headquarter comprises of administrative and financial divisions and technical divisions consisting of weather forecasting and aeronautical, meteorological networks and earthquake management, hydrology, and climate; while 16 provincial and one special zone offices operate hydrometeorological stations. He cited that there are 123 hydrological stations, 117 meteorological stations, and 59 discharge stations. He articulated that DMH is using MRCFFG products to prepare operational flash flood warnings and that local forecasters were trained on the MRCFFG system in February 2015. He also noted that a user guide had been developed. He continued by explaining MRCFFG products for Lao PDR and their usage. He depicted data and information dissemination schema, showing dissemination of warnings to various national authorities and concerned organizations such as national Mekong River Committee, national disaster management office, and media. He stated experiences and lessons learnt from using the MRCFFG system, and how knowledge and skills of the forecasters on the interpretation of the MRCFFG products has increased. He also indicated that they are using Arcview GIS software with the MRCFFG products and are producing analyses of satellite rainfall and images for the flash flood affected regions, leading to enhanced awareness of the situation and preparations for floods. He concluded his presentation citing : 1) the need for calibration of satellite precipitation data with the ground measurements; 2) feedback and reporting of flash floods occurrences from the field are not sufficient; and 3) need a database for hydrometeorological hazards such as flash flood hazards, floods, and storms.

During the facilitated discussions, he mentioned that internet bandwidth of the DMH is not sufficient to access the hydrometeorological products available on the internet such as MRCFFGS and SWFDP-SEA.

4.2.3 Myanmar

The expert from Myanmar, Mr Win Maw, provided an overview of the Department of Meteorology and Hydrology. He cited that there are 51 synoptic stations reporting to GTS, 8 aviation stations, 30 AWOS stations, 17 agro-met stations, 121 gauges, and 4 weather RADARs. He stated that WRF mesoscale model, global model from the Japan Meteorological Agency (JMA), DIANA tools from the Norwegian Meteorological Institute, and storm surge model from JMA are available for making short-term, medium-term weather and ocean forecasts. He articulated flood forecasting methods for daily and seasonal water level forecasts as being river stage correlation method, multiple regression method, Integrated Flood Analysis System (IFAS), and HEC-HMS are used for the former, while flood characteristic occurs in analogue years, seasonal weather forecast, compression of current flow with the individual hydrograph for the last ten years, average flow of the last ten years, and flood frequency analysis are used for the latter. After showing images of flow measurements and hydrometeorological network, he explained administration structure of the Department of Meteorology and Hydrology. He said that flood/flash floods and severe weather warnings and bulletins are prepared such as significant water level bulletin and flood bulletin and disseminated to relevant authorities such as public and media via SMS, email, fax, and Common Alerting Protocol (CAP). He concluded his presentation showing cases of flash flood events in Myanmar that inflicted heavy economical losses and caused loss of lives.

4.2.4 Thailand

The expert from Thailand, Mr Surapong Sarapa, provided an overview of the Thai Meteorological Department (TMD) including the weather and climate of Thailand, administrative structure, current infrastructure, and weather forecasting and warning system. He stated that Thailand is under the influence of two monsoon seasons: first one is the southwest monsoon that takes places from May to October in which the Inter-Tropical Convergence Zone (ITCZ) moves northward, while the second period covers from November to February in which ITCZ is situated in the south. He showed the climatological rainfall distribution diagrams, including mean monthly rainfall from 1981 to 2010 for thirty years. It is of 17 mm in January and reaches its maximum value of 253 mm in September. As an example of showing influence of tropical storms on the rainfall distribution, he depicted development and dissipation of the tropical storm "Rai" that produced 150.2 mm of rainfall on 12-14 September 2016. He stressed that heavy rainfall, which causes flooding, is induced by the monsoon trough. He stated that approximately 1000 employees work for the TMD- 400 of whom work as meteorologists in various departments. He cited the observation network components include: 122 synoptic stations, 12 upper air stations including 5 radiosonde stations, 20 Doppler weather RADARs, 87 AWOS, 930 automatic rain gauges, and a seismic observation network. He described the satellite products and their applications such as cloud top temperature, rainfall estimate, and satellite nowcasting products. He articulated the use of the NWP products and placed them into two categories, the first being global NWP products are received from the global centres such as ECMWF, JMA, and NCEP; while mesoscale NWP products are being generated in house such as WRF and Wave Mode. He depicted some NWP products such as accumulated precipitation and their usage in weather and hydrological forecasting. He said that TMD has a very reliable GTS connection. He stated that severe weather forecasts and warnings and advisories are prepared by the TMD and disseminated to relevant users such as the Disaster Warning Center, local authorities, and media via TMD web portal, dedicated radio stations, SMS, fax, and hotline. He further stated that there is a dedicated Metalarm web portal for the severe weather warnings.

During the facilitated discussion, he mentioned that TMD prepares flash flood advisories and disseminates them to the National Disaster Warning Center, Department of Disaster Prevention and Mitigation of Ministry of Interior, which in turn warns public and takes responsive measurements. He also stated that Thailand has a separate flash flood warning system operationally used in issuance of the flash flood advisories but not the MRCFFG products. Participants recommended that it would be beneficial if forecasters use both systems, the MRCFFGS and flash flood warning system of the TMD, and compare the results. Samples of flash flood advisory and warning issued by the TMD and the National Disaster Warning Center are presented in ANNEX XI.

4.2.5 Viet Nam

The expert from Viet Nam, Mr Phung Tien Dung, provided an overview of the National Center for Hydrometeorological Forecasting (NCHMF) including flash flood forecasting and warning, weather forecasting, nowcasting, and hydrometeorological network. He stated that Viet Nam is under the influence of the tropical monsoon of Southeast Asia where heavy rainfall induced by typhoons causes flooding, flash floods, and landslides particularly on the mountains of the northern and central regions. He then showed a flash flood frequency map for the period of 1990 and 2010. He explained that flash flood warning and forecasting are made in two ways. The first one is general forecasting and warning done in three steps: step 1, analysis of the weather conditions that may cause heavy rainfall; step 2, prepare warnings for the catchments based on the QPF; step 3, prepare warnings based on the observed rainfall. The second one is the automatic warning system installed in Son La and Lao Cai Provinces. He continued to explain the application of the MRCFFG products in issuance of flash flood warning for a flash flood event that took place in Lao Cai province in northern Viet Nam on 5 August 2016. He stated that satellite driven products are generated from the geostationary and polar orbiting weather satellites such as MTSAT, FY-2, HIMAVARI, NOAA, METOP, FY-1, and TRMM and showed their images. He articulated that Global Spectral Model (GSM), Global Forecast System (GFS), and Integrated Forecasting System (IFS) global models are used for daily weather forecasting, while HRM, WRF, COSMO, and NHM are run at the National Center for Hydrometeorological Forecasting. He said that WRF-ARW and HRM models have 15 km spatial resolutions and run twice and four times a day, respectively, while COSMO model has 7 km spatial resolution and runs once a day. He then showed NWP model products including QPE. He cited the components of the hydrometeorological network as: 186 synoptic stations, 1322 rain gauges, 400 automatic rain gauges, 257 hydrological stations, 8 pilot stations, 21 ocean meteorological stations, 6 radiosonde stations, and 7 weather RADARs. He showed organizational structure stressing that there are 20 employees with PhD degree and 151 employees with master degree. He concluded his presentation explaining the information flow of forecasts and warnings to the government authorities, media, and public through phone, fax and internet.

4.2.6 MRC

The expert from MRC, Mr Nguyen Quoc Anh, provided an overview of the daily MRCFFG system operations and provided information on the flash flood events caused by Tropical Storms, Inter Tropical Convergence Zone (ITCZ), Tropical Depression, and low pressure depressions. He explained the daily workflow to prepare a flash flood report. He stated that weather analyses are conducted to find out if heavy rain producing systems such as ITCZ, Tropical Depression, or Depression exist, if so, forecasters continue to analyze the MRCFFG products such as Mean Areal Precipitation (MAP), Average Soil Moisture (ASM), Flash Flood Guidance (FFG), and Persistent Flash Flood Threat (PFFT), and finally prepare the flash flood bulletin. He showed images of flash flood events and associated FFG products for the wet season from June to October, indicating that flash floods are one of the main causes of human and economic losses in this period. He explained uncertainties associated with the MRCFFG system, based on his experience, are: Hydroestimator (HE) occasionally underestimates the precipitation intensity; Merged Mean Areal Precipitation (MAP) estimation is also underestimated

due to use of an incorrect bias adjustment factor. He concluded his presentation recommending these points: NWP QPE should be incorporated in the MRCFFG system to provide better indicator of possible flash flood occurrences such as Forecast Flash Flood Threat (FFFT) and that some model parameters should be reset by using newly available soil moisture and land use/land data and that refreshment training should be conducted for forecasters from participating countries as well as MRC. Current MRCFFG products are given in ANNEX VII.

4.3 Visit to MRC and NMHS of Cambodia

Mr Ayhan Sayin had a meeting with MRC staff, including Mr Oudomsack Philavong, team leader, on 28 November 2016 to review the current status of the MRCFFG system and its operation. The MRCFFG user console and its products were displayed. The MRCFFG system does not have the same standard FFG products as those being implemented in other regions such as the Black Sea and Middle East FFGS and South East Europe FFGS. Particularly, it does not include mesoscale NWP QPF, microwave bias adjusted Global Hydro Estimator (MWGHE), Forecast Flash Flood Threat (FFFT), snow products, and the dashboard. Participants agreed that it is imperative to upgrade the system-hardware and software to reflect the latest developments allowing provision of better products and service to the MRC member states. It was stated that MRC does not prepare any flash flood warnings for its members but it puts selected MRCFFG products on its public web portal. Participants pointed out that MRC employees are recruited from the member countries and work for a maximum of six years.

He visited NMHS of Cambodia in the afternoon and had meetings in the Department of Hydrology and River Works and Department of Meteorology, respectively. After explaining the roles and responsibilities of the Department of Hydrology and Water Works, Mr Yim Saouth, Director, said that one hydrological forecaster has attended the FFG operational training at HRC but he is not using MRCFFGS products for his work. He further said that more forecaster training is needed for use of the MRCFFG products in issuance of flash flood warnings. He finally stated that Department of Hydrology, Department of Meteorology, and the National MR Committee are situated under the Ministry of Water Resources and Meteorology.

Mr Oum Ryna, Director of Meteorology, briefed Mr Sayin on the current forecasting capabilities and capacities. These include: 1) global NWP products and their availability; 2) available ALADIN mesoscale model; 3) GTS connection; 4) HIMAVARI satellite data reception and visualization; 5) 35 AWOS stations in operation; 6) operational S-band weather RADAR; 7) available nowcasting products. He reaffirmed that that Department of Meteorology is responsible for issuing flash flood warnings but forecasters are not able to access the MRFFGS user console to use its products. He stated that no forecasters from his department have participated in MRCFFG training and that forecasters are not working 24/7 but if there is emergency particularly during the wet season, they work during the night.

4.4 SWFDP-SEA and MRCFFGS Linkages

Mr Sayin informed the participants about the Severe Weather Forecasting Demonstration Project (SWFDP) of WMO, its objectives and goals, progress of SWFDP Regional Subprojects in different areas of the world including development of SWFDP for Southeast Asia (SWFDP-SEA). He also briefed participants on the potential expansion of SWFDP to cover many areas of the world within the next 5 years for the benefit of the developing countries including especially the least developed countries (LDCs) and Small Island Developing States (SIDSs). He also highlighted efforts being undertaken to integrate the SWFDP-Southern Africa with Southern Africa Region Flash Flood Guidance (SARFFG) project and prospects of potential linkages and integration of SWFDP-SA with SARFFG.

He stated that Quantitative Precipitation Forecasts (QPFs) from a high resolution numerical weather prediction model (also known as a Limited Area Model) covering specific domains within the project region would also be needed. He noted that in other regions, use was being made of Limited Area Models to estimate Forecast Mean Areal Precipitation (FMAP) for each sub-basin to establish the Forecast Flash Flood Threat (FFFT) thereby enhancing FFGS warning capabilities.

Participants discussed the importance of having high resolution limited area numerical weather prediction model products over areas where hazards of flash flooding exist and where populations and infrastructure are at risk. Participants also discussed in detail the merits and benefits of the lineage of MRCFFGS and SWFDP-SEA. SWFDP-SEA has the following products on its web portal²:

- Guidance Products: Short range and medium range;
- Satellite based products: Satellite images, satellite based rainfall, storm tracks, SCAT, and SCOPE;
- Global and Regional NWP products: GSM (JMA), GFS (NCEP), NAVGEM, GEM (SMC), ICON, COSMO, and WRF;
- Global EPS products; and
- Regional EPS products.

4.5 Mekong River Commission Region Flash Flood Guidance System (MRCFFGS) Training (Step 1)

4.5.1 MRCFFG System Development and Theoretical Background

Mr Eylon Shamir explained the development and theoretical background of the updated MRCFFG system in each of the following major categories: 1) Special analysis and threshold runoff; 2) Soil moisture, snow and FFG modelling; and 3) Satellite precipitation and bias adjustment. He stated that the basins, which were delineated from SRTM-90 meter DEM data, have average drainage areas of 150 square kilometers. He said that results of the delineation are used to compute geometric properties of each watershed, which are used, in turn, for the computation of *Threshold Runoff*³. He indicated that this is a constant property of a watershed and that Flash Flood Guidance (FFG) is then estimated from the Threshold Runoff, soil moisture deficit, and evapotranspiration.

He gave an overview of soil moisture, snow and Flash Flood Guidance modelling. He said that the Average Soil Moisture (ASM) product provides an estimate of current soil water in the upper soil layer, expressed as a fraction of saturation. He stated that Sacramento Soil Moisture Accounting (SAC-SMA) model, in which rainfall and snow melt are ingested as input data, is used to estimate ASM. He explained that parameter estimation within the soil model is based on soil texture and soil depth data as provided by the UN Food and Agriculture Organization (FAO). He then continued to explain the Flash Flood Guidance (FFG) model, specifying that it integrates Threshold Runoff, soil water content, and current precipitation and that it is updated every six hours.

He continued by explaining that satellite precipitation estimates are derived from geostationary and polar orbiting satellites, providing valuable information for the region where ground-based hydrometeorological observations are sparse. He said that Global Hydro Estimator (GHE) precipitation

² <https://swfdp-sea.com.vn/>

³ Threshold Runoff is defined as the amount of effective precipitation of a given duration which produces the volume of runoff required to cause bankfull flow at the watershed outlet of the draining stream.

with 4 km resolution is calculated using the Infra-Red (IR) channel, such that the rainfall rate is correlated with cloud top brightness temperature, while microwave precipitation estimate with 8 km resolution is based on backscattering measurements from raindrops in the microwave spectrum. He also mentioned that there is 18-26 hours latency in operation and that GHE is corrected using microwave precipitation data. He finally articulated that two kinds of bias adjustments were employed. The first one is the climatological bias adjustment to determine the long-term bias in satellite precipitation within a given region using historical precipitation observations, while the second one is the dynamic bias adjustment using in-situ observations disseminated through the GTS.

4.5.3 Advances in FFGS Functionalities

Mr Eylon Shamir presented some of the FFG enhancements that could be complemented to the standard FFG system.. He touched upon the following four major topics:

- Multiple Mesoscale NWP ingestion;
- Urban Flash Flood Warning;
- Use of satellite inundation mapping to correct soil moisture; and
- Landslide susceptibility mapping.

First of all, he mentioned that it was the forecasters demand to include multiple mesoscale model input display on the FFGS forecaster console because each model behaves differently in different seasons event in months. Secondly, he explained that there is a growing demand for an urban flash flood early warning system to be incorporated into FFGS. He continued saying that a demonstration project for the urban flash flood early warning has been conducted for the city of Pretoria, South Africa and second one is being developed for Istanbul, Turkey. Thirdly, he showed a case study to correct soil moisture in the inundated regions in northern Cambodia by using MODIS satellite images. Finally, He showed a demonstration case study of landslide risk warning conducted in El Salvador that is based on a priory analysis of landslide susceptibility and a risk prediction based on FFGS rainfall and soil moisture data.

4.5.3 Overview of Current and Updated MRCFFG System and its Products

Mr Eylon Shamir provided an overview of the existing MRCFFG products. He stated that MRCFFGS, which became operational in 2009, does not include the latest developments such as microwave bias adjusted Global Hydro Estimator (MWGHE) precipitation, mesoscale NWP QPF, Forecast Flash Flood Threat (FFFT), and the dashboard. He showed the current MRCFFGS user console and explained its products:

- Hydro Estimator Satellite precipitation (HE Satellite);
- Merged Mean areal Precipitation (Merged MAP);
- Average Soil Moisture (ASM);
- Flash Flood Guidance (FFG); and
- Persistent Flash Flood Threat (PFFT).

He mentioned that the system receives some real time gauge data but efforts should be made to incorporate other available observation network of data such as Synoptic Stations. The current operational MRCFFGS user console is presented in ANNEX VII.

In his second presentation, he introduced the updated MRCFFG system, design philosophy and FFGS products by explaining their definitions and characteristics. He explained flash flood definitions of various organizations such as WMO and the American Meteorological Society (AMS). He listed the

natural causes of flash floods as being: 1) intensive rainfall from slow moving thunderstorms or tropical systems; 2) orographic rainfall in steep terrain; 3) soil saturation or impervious land surface; and 4) hydraulic channel properties. He cited the needs, saying that globally flash flooding is one of the deadliest hydrometeorological hazards, and there are very limited capabilities and capacities of the NMHSs to provide timely early warnings. He also explained the differences between riverine floods and flash floods, indicating that each has its own forecasting and early warning features. After explaining the importance of soil moisture on flash flooding, he provided an overview of the FFG fundamental concept, including definition of Flash Flood Guidance (FFG) with its applications; the end-to-end approach for flash flood warnings; and the FFG system components. Finally, he showed the updated MRCFFGS user interface and explained the following products:

- **Global Hydro Estimator (GHE) precipitation**, which is produced by US National Oceanic and Atmospheric Administration (NOAA) using Infrared (IR) channel (10.5 micrometre) of geostationary meteorological satellites;
- **Micro Wave adjusted Global Hydro Estimator (MWGHE) precipitation**, which is estimated by correcting GHE precipitation with Micro Wave satellite precipitation;
- **Gauge Mean Areal Precipitation (Gauge MAP)**, which is estimated by using WMO synoptic reports obtained from the GTS network;
- **Merged Mean Areal Precipitation (Merged MAP)**, which is derived from the best available mean areal precipitation estimates from GHE precipitation or MWGHE precipitation or Gauge MAP or Radar estimated precipitation.
- **Average Soil Moisture (ASM)**, which indicates upper soil (20-30 cm) water content, including free and tension water;
- **Flash Flood Guidance**, which is an amount of actual rainfall that may cause bankfull flow conditions at the outlet of a sub-basin for a given duration (e.g., 1, 3, or 6 hours);
- **WRF model QPF products**;
- **Forecast Mean Areal Precipitation (FMAP)**, which is estimated by using LAM QPF data such as WRF, ALADIN, and COSMOS models; and
- **Flash Flood Threat (FFT) products**, which indicate the possibility of flash flood occurrences at the outlet of a particular sub-basin, including Imminent Flash Flood Threat (IFFT), Persistence Flash Flood Threat (PFFT), and Forecast Flash Flood Threat (FFFT).

The updated MRCFFGS user interface console, its products, and dashboard that are presented in ANNEX VIII and IX.

During the facilitated discussions after his presentations, it was pointed out that MRCFFG products for entire Thailand were not displayed on the user interface console, but only the part of Thailand that is within the domain of Mekong River basin is displayed because MRC puts FFGS products on the MRC public web portal. Representatives of Thailand said that MRCFFG products should not be put on a public web portal because they should only be used by trained forecasters and interpreted by them for issuance of flash flood warnings. Participants discussed this matter in detail and concluded that MRC should work internally with its representatives to define a format to put the products on the MRC public web portal. Representatives of Thailand stated that if such a format is agreed, MRCFFG products for all of Thailand could then be displayed on the user portal. It was further pointed out that Myanmar is included in the MRCFFG system but its products masked due to the fact that MRC has not decided yet if Myanmar can be included in MRCFFGS. ANNEX X shows the current operational FFG (left) and upgraded FFG (right) and its display domains.

4.5.4 Case Studies

Mr Ayhan Sayin presented two case studies in which he first depicted a flow chart describing how to prepare flash flood warnings by using a top-down approach from synoptic analysis to interpretation of

the FFGS products. He explained that firstly, weather analysis and forecasting tools and models such as surface charts, 850 hPa and 500 hPa charts, and NWP QPF products should be analyzed to see the current weather outlook and weather conditions are favorable for the occurrences of flash floods; secondly, mesoscale and nowcasting analysis including RADAR and weather satellite images, if available, should follow to make smaller scale analysis such as instability and development of convective clouds; thirdly, FFGS products should be interpreted starting from diagnostic products and ending with prognostic products; and finally, the preparation of flash flood bulletins and warnings should be made provided conditions for the flash flood occurrences are suitable.

In Mr. Sayin's first presentation, he presented a flash flood event that occurred in South East Europe on 6-8 March 2016 causing loss of lives and extensive economical losses in Montenegro and Serbia. He articulated that flash floods and floods that were induced by the central Mediterranean depression associated with frontal system and coupled with the orographic lifting are very common phenomenon in the region. In his second presentation, he presented a case study on a flash flood event that took place in Georgia on 12-14 June 2015 in which more than forty people were killed and millions of dollars economical damage were inflicted according to the UNDP report. He stated that the flash flood was caused by the occurrence of severe convective storms during the night. He said that there were two important lessons learned from this case study: firstly, convective rainfall may not be detected neither by FFG system nor NWP models. If this is the case, weather satellite and/or weather RADAR nowcasting products, depending on the availability of them, are very useful tools to be used in flash flood forecasting. Secondly, 24/7 working hours are extremely important because flash flood may happen at any time, which was the case in this event.

4.5.5 BSMEFFGS Verification Results

Mr Ayhan Sayin's presentation built upon that of Mr Eylon Shamir's presentation where he demonstrated the operational capabilities of the Black Sea and Middle East Flash Flood Guidance (BSMEFFG) system and illustrated the use of its derived products. He also provided an overview of verification results for the BSMEFFG system for the years of 2013 and 2014. He stated that Probability of Detection (PoD) was 70% in 2013, while it was 55% in 2014. He concluded his presentation explaining that PoD was lower in 2014 because of the fact that frequency of the convective storms were higher and that satellite estimation and numerical weather forecasts of precipitations intensity and amount are relatively poor in comparison with synoptic and mesoscale systems.

4.6 MRCFFGS Hydrometeorological Training

Mr Eylon Shamir stated that training was an integral part of the project, and extensive training would be provided to the participant countries' forecasters. He showed the schematic diagram outlining the FFGS hydrometeorological training programme, which is contained in ANNEX III of this report. He explained that it consisted of five steps:

- Step 1 introductory regional workshop;
- Step 2 eLearning hydrometeorological training;
- Step 3 specialized training at HRC;
- Step 4 regional operations training workshop; and
- Step 5 regional operational sustainability workshops.

He stated that when the training was completed, forecasters should be confident and competent to use FFGS products for flash flood forecasting and the provision of early warnings. He emphasized the differences between previous training activities and new ones that Step-2 on-line training has been developed. He stated that it consists of five major modules: elements of meteorology, elements of hydrology, Flash Flood Guidance products, GIS, and remote sensing. He stressed that on-line training

is a prerequisite to be eligible to attend the Step-3 operational training at HRC. He further stated that those forecasters who successfully completed Step-3 and 4 training may receive WMO flash flood trainer certificate and involve in Step-5 sustainability training.

During the facilitated discussions, participants stated that four MRC staff and one forecaster from each NMHS have attended two operational training at HRC in two different occasions. They suggested that within the scope of the new flash flood hydrometeorological training programme, more forecasters from the participating NMHSs should be involved in training because those MRC staff that had participated in the operational training are no longer working at MRC. It was also stated that employment duration of the MRC staff, who are recruited from the member countries, are limited to a maximum of six years. This could be a hurdle for the sustainability of provision of training activities by the MRC.

4.8 Project Implementation Plan

Mr Ayhan Sayin described the revised project implementation plan, showing its major tasks, milestones, and timeline. The following activities were mentioned and had focused discussions on how the process may move forward: 1) joint Mekong River (MR) Committee meeting will decide on the submission of the letters of Agreement (LoC) to WMO and conclusion of a cooperation agreement with WMO; 2) provision of newly available historical hydrometeorological and in-situ data to HRC through the RC; 3) on-site installation of the upgraded system at the Regional Center; 4) completion of on-line training courses (Step 2); 5) operational training at HRC (Step 3); 6) other training activities (Step 4 and 5). Participants unanimously agreed on the implementation of the revised implementation plan saying that they would do their utmost to comply with the plan. Revised MRCFFGS implementation plan is provided in ANNEX VI of this document.

4.9 Management Aspects

According to the typical implementation requirements document, a Project Steering Committee (PSC) is established to provide overall governance of the project and its related activities throughout the duration of the project. Its membership and the terms of reference are confirmed and amended as deemed necessary during the first constituting session of the PSC. The PSC consists of focal points or their alternates from each of the participating NMHSs as nominated by the Member's Permanent Representatives and representatives of the project partners, while additional experts/representatives are to be invited by the PSC as needed on an ad-hoc basis, and observers may also be invited by the PSC to participate in meetings.

On the other hand, the project governance model for the current MRCFFG project is different than described above as it was implemented through MRC rather than through NMHSs, as it predated the WMO-NOAA NWS-HRC-USAID partnership. All decisions regarding the implementation of this project have been taken by the joint MR committee that consists of representatives of the national MR committees. As presented and discussed at the meeting, the existing governance structure of the MRCFFG system could be aligned with that of other regional FFG projects.

5. Conclusions of the Steering Committee Meeting 1

During the first Steering Committee Meeting of the MRCFFGS that consisted of representatives of MRC, Cambodia, Lao PDR, Thailand, Viet Nam, WMO, and HRC; participants discussed a variety issues in accordance with the meeting agenda and reached the following conclusions:

1. There was an agreement among the participants that an upgraded MRCFFG system would significantly improve the capabilities of NMHSs in Southeast Asia to produce timely and

accurate flash flood warnings induced by heavy rainfall, thereby contributing to disaster risk reduction by saving lives and reducing property damages.

2. Participants understood the roles and responsibilities of the Regional Centre and NHMSs, noting that cooperation and collaboration amongst the project partners is the key to success for the project.
3. Participants noted and expressed their appreciations on the upgraded MRCFFG system in which a number of new features have been included such as WRF mesoscale NWP model and its associated QPF, microwave adjusted GHE, snow products, and the dashboard. They agreed that the upgraded system would enhance capacities of the participating NMHSs to issue flash flood warnings.
4. Participants became familiar with the updated MRCFFGS forecaster interface and its products: Global Hydro Estimator (GHE), Microwave adjusted GHE (MWGHE), gauge Mean Areal Precipitation (MAP), merged MAP, Average Soil Moisture, Flash Flood Guidance (FFG), Flash Flood Threats (FFT), Forecast Mean Areal Precipitation (FMAP), Mean Areal Temperature (MAT), and satellite snow coverage as well as dashboard. Participants agreed that these were complementary with each other and provided a good oversight of what conditions existed and what might happen over the forecast horizon.
5. Participants noted that the MRCFFG system became operational in 2009 and agreed on the provision of new historical hydrometeorological and geophysical spatial data, if such data exist, to the Hydrologic Research Center (HRC) through the RC to update model parameters and update the bias corrections.
6. Participants further noted the necessity of sharing real-time data through the GTS to allow real-time bias precipitation adjustment and use of other surface data in model calculations. They agreed to provide their updated lists of SYNOP stations reporting to GTS and their metadata to HRC. They further noted that inclusion of more in-situ observations into MRCFFG system that are not reporting to the GTS may improve the quality of its products.
7. Participants agreed that inclusion of available weather RADAR precipitation data may improve the accuracy of the MRCFFG products and affirmed that urban flash flooding is very important problem in the region during the wet season.
8. Participants urged linkages between the Severe Weather Forecasting Demonstration Project – Southeast Asia (SWFDP-SA) and MRCFFG system and agreed that use of its products such as high resolution NWP QPF, if available, may improve the accuracy of assessing the flash flood threats to provide better flash flood warnings, particularly in the mountainous regions. They recommended that satellite nowcasting products retrieved from HIMAWARI satellite data of Japan Meteorological Agency, currently being the most advanced meteorological satellite, may also significantly contribute to the improvement of accuracy of flash flood warnings.
9. Participants agreed on the revised implementation plan and noted the milestones such as convening of the Joint MR Committee meeting to discuss submission of LoC from the participating countries to WMO and concluding a cooperation agreement between MRC and WMO; provision of hydrometeorological and in-situ data; on-site system installation; and flash flood hydrometeorologist training programme.
10. Participants agreed on the implementation of the flash flood hydrometeorological training programme (step 1-5) and that efforts should focus on training forecasters from the participating NMHSs, stressing that the majority of the previous trainees who attended the

operational training at HRC were from MRC staff - four trainees from MRC and one trainee from each NMHS.

11. All aspects pertaining to the management of the MRCFFG system such as installation of the upgraded MRCFFG system at the MRC and conclusion of a cooperation agreement between the MRC and WMO, will be considered at the earliest possible joint MR committee as this is the current governing body of this regional project.
12. Noting that the MRCFFG products for areas of Thailand, that are outside the Mekong River Watershed, are currently masked on the MRCFFG forecaster console and MRC web portal, participants agreed that MRC and member states will work together to define a new format of the MRCFFG products that will be put on the MRC public web portal as requested by the representatives of Thailand who indicated that the mask could be removed after a satisfactory format would be agreed upon.
13. Participants appreciated that efforts are being made to develop the Flash Flood Guidance products for Myanmar and noted that decision on the inclusion of Myanmar in the MRCFFG System will only be made by the joint Mekong River Committee.

6. Closing of the Steering Committee Meeting 1

Closing remarks were made by WMO, HRC, MRC, and participants. Thanks were also extended to all attendees for their active participation in the workshop and spirited involvement in the discussions, which contributed to the successful conclusion of the workshop.



**FIRST STEERING COMMITTEE MEETING (SCM 1)
MEKONG RIVER COMMISSION FLASH FLOOD GUIDANCE (MRCFFG)
SYSTEM**

**Phnom Penh, Cambodia
29 November–1 October 2016**

List of Participants

MRC	
<p>Mr Oudomsack Philavong Team Leader Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia</p>	<p>Tel: +855-23-425-353, Ext. 2021 HP: +855-89-9262-159 Fax: +855-23-425-363 Email: oudomsack@mrcmekong.org</p>
<p>Dr Paradis Someth Water & Climate Change Monitoring Specialist Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia</p>	<p>Tel: +855-23-425-353, Ext. 2091 HP: +855- Fax: +855-23-425-363 Email: someth@mrcmekong.org</p>
<p>Mr Nguyen Quoc Anh Operational Hydro-Meteorologist/Forecaster Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia</p>	<p>Tel: +855-23-425-353, Ext. 2109 HP: +855-97 833 7786 Fax: +855-23-425-363 Email: anh@mrcmekong.org</p>
<p>Mr Yos Saravy System and IT Assistant Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia</p>	<p>Tel: +855-23-425-353, Ext. 2108 HP: +855-97 7031 222 Fax: +855-23-425-363 Email: saravy@mrcmekong.org</p>
<p>Mr Nuon Kunthea Mapping and GIS Assistant Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia</p>	<p>Tel: +855-23-425-353, Ext. 2105 HP: +855-97 8658 188 Fax: +855-23-425-363 Email: kunthea@mrcmekong.org</p>
<p>Dr Phung Katry Hydrologist</p>	<p>Tel: +855-23-425-353, Ext. 2101 HP: +855-11 837 056</p>

Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia	Fax: +855-23-425-363 Email:Phungkatry11@gmail.com
Ms Sotheavy Cheap Secretary Flood Forecasting Team, Technical Support Division, Office of the MRC Secretariat in Phnom Penh (OSP), # 576 National Road No. 2, Chak Angre Krom, Meanchey, P.O. Box 623, Phnom Penh, Cambodia	Tel: +855-23-425-353, Ext. 2101 HP: +855-12-628-624 or 97-702-0797 Fax: +855-23-425-363 Email: sotheavy@mrcmekong.org
Cambodia	
Mr Oum Ryna Director Department of Meteorology, Ministry of Water Resources and Meteorology (MOWRAM) # 364 Monivong Blvd, Sangkat Phsar Doerm Thkouv, Khan Chamkar Mon, Phnom Penh, Cambodia	Tel: +855-23 725 989 HP: +855-16 756 389 Fax: +855-23 426 345 Email: rynaoum@yahoo.com
Mr So Im Monichoth Deputy Director Department of Meteorology, Ministry of Water Resources and Meteorology (MOWRAM) # 364 Monivong Blvd, Sangkat Phsar Doerm Thkouv, Khan Chamkar Mon, Phnom Penh, Cambodia	Tel: +855-23 725 989 HP: +855-16 756 389 Fax: +855-23 426 345
Ms Pot Peou Vice Chief of Research and Flood Forecasting Office Department of Hydrology and River Works, Ministry of Water Resources and Meteorology # 364 Monivong Blvd, Sangkat Phsar Doerm Thkouv, Khan Chamkar Mon, Phnom Penh, Cambodia	Tel: +855-23-425-645 Fax: +855-23-425-645
Mr Pheng Seng Meng Technical Officer Department of Hydrology and River Works, Ministry of Water Resources and Meteorology (MOWRAM) #364 Preah Monivong Blvd., Phnom Penh, Cambodia	Tel: +855-23-425-645 Fax: +855-23-425-645
Mr Thoun Sokchea Deputy Director IKM Department, Cambodia National Mekong Committee # 364 Monivong Blvd, Sangkat Phsar Doerm Thkouv, Khan Chamkar Mon, Phnom Penh, Cambodia	Tel: 855-23 216 514 Fax: 855-23 218 506
Mr Chhun Dara Technical Staff IKM Department, Cambodia National Mekong Committee # 364 Monivong Blvd, Sangkat Phsar Doerm Thkouv, Khan Chamkar Mon, Phnom Penh, Cambodia	Tel: 855-23 216 514 Fax: 855-23 218 506
Lao PDR	
Mr Khanmany Khounphonh Director General	Tel: +856 21 215 010 HP: +856 5430 1820

Hydrological Division, Department of Meteorology and Hydrology, Ban Akard, Souphanouvong Avenue, Sikhottabong District, Vientiane, Lao PDR	Email: k.khanmany@gmail.com
Mr Prasith Deemaneevong Deputy Head Hydrological Division, Department of Meteorology and Hydrology, Ban Akard, Souphanouvong Avenue, Sikhottabong District, Vientiane, Lao PDR	Tel: +856 21 216 672 HP: +856 20 5562 1513 Fax: Email: prasithd@gmail.com
Myanmar	
Dr Tin Mar Htay Technical Officer Office No. 5, Department of Meteorology and Hydrology, (DMH), Ministry of Transport and Communication, Nay Pi Taw, Myanmar	Tel: +95-67- 411 031 HP: +95-9-250 954 664 Fax: +95-67-411523 Email: Dg.dmh1@gmail.com tmarhtay@gmail.com
Mr Win Maw Assistant Director Hydrological Division, Department of Meteorology and Hydrology, (DMH), Ministry of Transport and Communication, Nay Pi Taw, Myanmar	Tel: + 95-67-411 031 HP: +95-9-250 954 659 Fax: +95-67-411523 HP: +95-9799173932, or 95-9250107640 Email winmaw.kk@gmail.com dg.dmh1@gmail.com
Thailand	
Assoc. Prof. Chaiyuth Sukhsri Technical Advisor/Member of TNMC Secretariat TNMS, Mekong Management Bureau, Department of Water Resources, Ministry of Natural Resources and Environment, 180/3 Rama 6 Road, Soi Phibul Watana Building, , Phayathai, Bangkok 10400, Thailand	Tel: +66 298 6605 HP: +66-89-666 8375 Fax: Email: csschaiyuth@yahoo.com
Mr Surapong Sarapa Director Central Weather Forecast Division, weather Forecast Bureau, Thai Meteorological Department, # 4353, Sukumvit Road, Bang-na, Bangkok 10260, Thailand	Tel: +66-2-399-4001 HP: +66-89-479 8065 Fax: +66-2-399 4001 Email: kopaball@hotmail.com
Viet Nam	
Mr Phung Tien Dung Deputy Chief Hydrology Forecasting Division (Central, Highland Southern Regional), National Center Hydro-Meteorological Forecasting (NCHMF), # 4 Dang Thai Than Street, Hoan Kiem, Ha Noi, Viet Nam	Tel: +84-4-822 4922 HP: +84-91-357 1114 Fax: +84-4-822 4921 Email: ptdung77@gmail.com
WMO	
Mr Ayhan Sayin Scientific officer World Meteorological Organization Hydrological Forecasting & Water Resources Division 7bis, avenue de Paix, Case Postale No. 2300, 1211 GENEVA 2 Switzerland	Phone: + 41 (0) 22 730 83 31 Fax: +41 (0) 22 730 80 43 E-mail: asayin@wmo.int
HRC	
Dr Eylon Shamir Ph.D.	Phone:+1-858-798-9440

Hydrologic Research Center
11440 West Bernardo Court, Suite 375
San Diego, CA 92127

Email: eshamir@hrcwater.org



USAID
FROM THE AMERICAN PEOPLE



**FIRST STEERING COMMITTEE MEETING (SCM 1)
MEKONG RIVER COMMISSION FLASH FLOOD GUIDANCE (MRCFFG)
SYSTEM**

Phnom Penh, Cambodia

29 November–1 October 2016

Final Agenda

Day I

08:30-09:00 Registration

09:00-09:30 Opening Ceremony

Welcome speeches by the representatives of MRC, WMO, and HRC

09:30 – 10:00 Photo session

10:00 – 10:30 Coffee Break

10:30 – 10:45 Selection of the session chair and review of the agenda and Participants self-introductions (All)

10:45 – 11:15 Objectives of the meeting and overview of the global FFG System and (WMO)

11:15- 11:30 MRCFFG Project implementation status (HRC)

11:30 – 12:30 Overviews of existing flash flood forecasting and warning infrastructures of the participating countries (Country presentations)

- Local capacity for the provision of flash flood early warnings
- Local capacity for weather forecasting and nowcasting (Global and limited Area Models, meteorological data processing and visualization software)
- Current hydrometeorological networks (number and types of meteorological and hydrological stations, data dissemination methods, GTS reporting, radiosonde stations, databases)
- Organizational structure and human resources (7/24 working, number of trained forecasters, forecasting department)

- Collaborations with emergency management agencies other governmental and non-governmental (private sector, TV, Radio etc.) organizations
 - Overview of products and services provided

12:30 – 14:00 Lunch Break

14:00 – 14:30 Roles and Responsibilities of the Regional Centre and participating NMHSs (WMO)

14:30 - 15:00 Current operational status of MRCFFG System and availability of MRCFFG services and products to the participating countries for issuance of flash flood warnings (MRC)

15:00 – 15:30 Operational Aspect of BSMEFFG System (WMO)

15:30 – 16:00 Coffee Break

16:00 - 16:30 Organizational and Management Aspect and Project Cycle (WMO)

16:30 – 17:00 SWFDP-Southeast Asia (WMO)

19:00 Welcome dinner

DAY II

09:00 – 09:15 Overview of day I presentations/discussions (All)

09:15 – 10:30 MRCFFG system development and review of theoretical background (HRC)

- Design Philosophy and Introduction to Modelling Components
- Data Used for Development
- Satellite Precipitation Estimation and bias adjustments
- Soil Moisture Model and Parameterization

10:30 – 11:00 Coffee Break

11:00-11:30 MRCFFG system development and review of theoretical background (HRC) (Cont.)

- Runoff Estimation
- Flash Flood Guidance
- Flash Flood Threat

11:30-12:00 Overview of the Mekong River Commission Flash Flood Guidance products (HRC)

- Diagnostic precipitation products (GHE, MWGHE, Merged MAP)
- Prognostic precipitation products (WRF, FMAP)
- Soil Moisture (ASM)
- Flash Flood Guidance (FFGS)

- Threats (IFFT, PFFT, FFFT)

12:00 – 12:30 Demonstration of an Operational FFG System: Black Sea and Middle East Flash Flood Guidance (BSMEFFG) System (WMO)

12:30 – 14:00 Lunch Break

14:00 – 14:30 How to prepare flash flood warnings: Methodology (WMO)

- Weather analysis and forecasting
- Mesoscale and Nowcasting Analysis
- Weather RADAR and Satellite images
- Interpretation of FFG Products

14:30 – 15:00 A flash flood case study (WMO)

15:00 – 15:30 A flash flood case study (HRC)

15:30 – 16:00 Coffee Break

16:00 – 16:30 Preparation of Flash Flood Bulletins and their verification (WMO)

16:30 – 17:00 Concept of Operation (WMO)

Day III

09:00 – 09:15 Overview of previous day presentations/discussions (All)

09:15 – 10:30 Hands-on Exercise for Past Events in the region (Guided by HRC, All)
(example “daily operations”)

- Daily Weather Briefing
- Hydrologic Output
- FFG Product Analysis
- Flash Flood Threats
- Discussion

10:30 – 11:00 Coffee Break

11:00 – 11:30 Advances in FFG System (HRC)

- Multi-Model QPF Ingestion in FFGS
- Landslides
- Urban flooding early warning system
- Riverine Routing

11:30 – 12:00 Flash Flood Hydrometeorologist Training Programme: Step 1-5 (HRC)

12:00 – 12:30 Cooperation Agreement between WMO and the Regional Centre (WMO)

12:30 – 14:00 Lunch Break

14:00 – 14:30 Review of Work Plan

- Adjustments and next steps

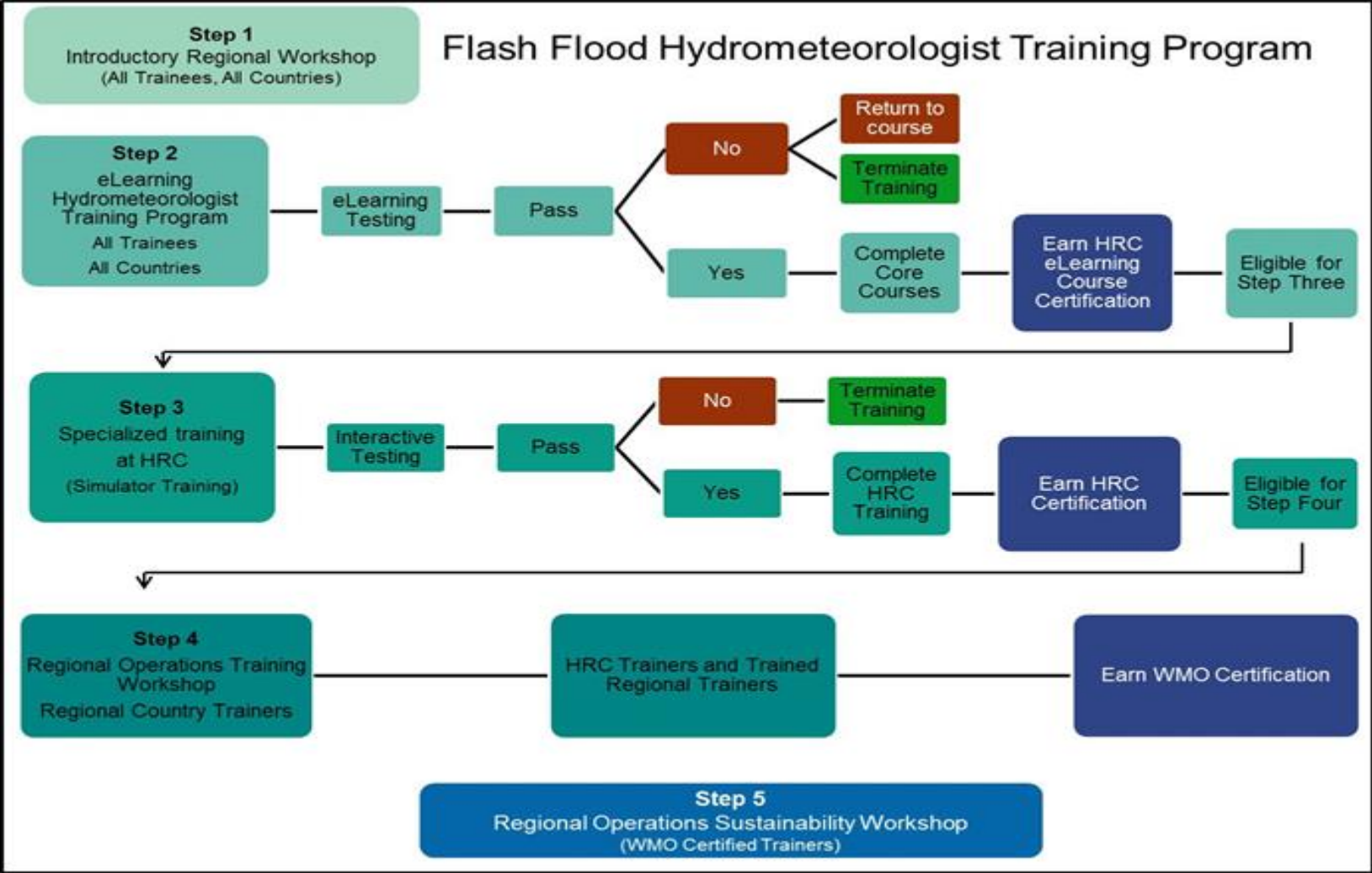
14:30 – 15:30	Final Discussions, conclusion and recommendation for further development (All)
15:30-16:00	Closing statements & closure of the meeting

- **End of Workshop**

Flash Flood Hydrometeorological Training Programme

During the course of the MRCFFG System implementation for a region, training will be provided to forecasters on the scientific basis and operations of the system. The training programme is a five step blended learning model - known as the Flash Flood Hydrometeorologist Training (FFHT) Programme. The five step programme includes:

1. Introductory in-country workshops and meetings;
2. eLearning programme to support system operations, product interpretation, system validation, including the use, management, and interpretation of output from the system, and the development of protocols to alert response agencies and the public of an impending or existing threat. For each completed course learners earn an HRC Course Certification, once they have completed the core curriculum they are eligible for Step Three;
3. Advanced Operations and Interactive Simulator Training at the Hydrologic Research Centre to assist with reviewing and assessing the operating versions of the system. Included is the Interactive Simulator training to provide the user with the skill to interpret and validate skill using real flash flood events. Upon successful completion of the Advanced Operations Training each learner earns an HRC Advanced Training Operations Certification; once they have completed this step they are eligible for Step Four;
4. Regional Operations Training Workshop – where HRC trainers in combination with Trained Regional Trainers provide in-country workshop. Upon successful completion of this stage of training Regional Trainers earn a WMO Certification as hydrometeorologists; and
5. Regional Operation Sustainability Workshop led by WMO certified trainers acts as refresher training in operations, overview of data requirements, system verification and user validation.



ANNEX IV

Data Requirements

For the development and operation of Flash Flood Guidance System, local historical and/or climatological hydrometeorological and geomorphologic, and real-time data are required. They are used for, among others, model parameterizations, calibrations, bias adjustments. Use of the higher resolution spatial and temporal local data in the FFG models is critical for the system performances. At the absence of local data, they will be obtained from international organizations like soil data from FAO (Food and Agricultural Organization). Therefore, participant countries are advised to collect, arrange and provide the following data types in required formats, depending on the availability of them.

A. NMHS Capacity Information

Institutional capacities, responsibilities:

- Hydrometeorological observation network, data processing and visualization tools;
- River and flash flood forecasting and early warning tools;
- Nowcasting tools;
- QPE/QPF tools and models;
- IT capabilities; and
- Organization structure (forecasting department, regional offices etc.,).

B. Spatial GIS Data, Maps

- Digital terrain elevation data (quality controlled);
- Stream network;
- Lakes/reservoirs/wetlands;
- Soil type, texture and depth;
- Vegetation cover, and land usage; and
- Monthly climatological maps of precipitation, temperature and potential evapotranspiration.

C. Spatial GIS Data, Maps

Channel cross-sectional Information for natural channels with drainage areas less than 2,000 km². The following hydrometeorological data, 5-20 years in record length, preferable in digital format:

- Precipitation (hourly, daily, monthly), covering at least past 5 years as much as available;
- Surface air temperature (hourly, daily, monthly);
- Top soil moisture (daily, weekly, monthly);
- Streamflow discharge for local streams with drainage areas less than 2000 km² (hourly, daily, monthly); If streamflow discharge data are unavailable, stream stage data (hourly, daily, monthly) and associated stage-discharge curves (rating curves), also for local streams;

- Snow depth, snow water equivalent (SWE) and snow coverage (hourly, daily monthly);
- Flood frequency analysis (regional and local);
- Flash flood occurrences (regional and local);
- Stream geometry studies for small streams;
- Climatological precipitation and flood studies; and
- Karst flow measurement studies.

If above data are unavailable, such hydro-meteorological and climatological data as monthly precipitation; surface air temperature; pan-evaporation/evapotranspiration; soil moisture; stream flow; radiation; wind and humidity; snow depth and coverage and SWE should be provided.

D. Real-Time Data Requirements

FFG system uses real-time meteorological observations in WMO synop format that are disseminated through WMO GTS, including the following parameters, among others:

- Precipitation;
- Surface temperature, humidity, wind speed/direction, pressure, solar radiation;
- Snow depth and SWE; and
- Soil moisture.

Besides the synoptic reports, if additional hydrometeorological observations are available, that would be transferred to the regional centre through ftp services, may improve the system performances.

NMHS Observation Network Metadata Requirements

The following metadata for the rain gauges, weather stations, and stream gauges are to be provided:

- Geographical locations (latitude and longitude in decimal degrees);
- Elevation in meters;
- Type of stations and WMO station numbers(synoptic, climate);
- Current operational status (Automatic, Manual);
- Observation interval (hourly, 3-hourly, 6-hourly etc);
- Available sensors (Precipitation, Temperature, Humidity, Soil Moisture, Dew Point, Snow, SWE etc.);
- Total number of stations and number of synoptic stations that reports to GTS;
- Data transmission type (HF/VHF radio, wide area network, GPRS, satellite etc.);
- Data quality control applied (y or n); and
- Existing database (Oracle, Informix etc.).

Data Priorities for the CARFFG System

REAL-TIME DATA

Real-time data is considered the highest priority for the operational FFG System.

Priority	Data Type	Time Resolution
1	Meta data for all gauges ⁺	
1	Precipitation*	Hourly or 6-hourly preferred -OR- 3-hourly or daily
1	Surface temperature*	Hourly or 6-hourly preferred
2	Snow depth / snow water equivalent	6-hourly or daily
3	Stream flow	6-hourly or daily
4	Soil moisture measurements	6-hourly or daily
5	Humidity, wind, solar radiation	6-hourly or daily

⁺ Meta data includes station name &/or identifier, coordinates in LAT/LON, and elevation

* Precipitation, temperature, and snow observations may be used directly by system. Soil moisture, stream flow and other meteorological observations (frequent less available)

are provided as information through system interface and may be used by forecaster to evaluate certain system output products.

HISTORICAL DATA

Historical data is necessary for model development and evaluation of FFG System components. The items listed below in Section 1 are higher priority, and considered equal level of priority as the corresponding priority levels of real-time data. Additional information requested in Section 2 and 3 may be during development as such data is available. The priority assignments are grouped together for Sections 2 and 3, and follow the priority level of Section 1.

(1) FOR ANALYSIS PERIOD OVERLAPPING SATELLITE ESTIMATES:

1.a) PRECIPITATION BIAS ANALYSIS

Priority	Data Type	Time Resolution	Period of Record
1	Gauge Precipitation*	Hourly preferred -OR- 3- or 6- hourly -OR- Daily	2012 - current
1	Meta data for all gauges ⁺		

* Gauges with good spatial coverage and relatively uniform density across country. Quality controlled data is required. Typically, most information is available from daily reporting stations.

⁺ Meta data includes station name &/or identifier, coordinates in LAT/LON, and elevation.

1.b) Hydrologic Model Calibration

Priority	Data Type	Time Resolution	Period of Record
1	Meta data for all gauges		
2	Surface air temperature	Hourly or Daily preferred -OR- 3- or 6- hourly	2012 - current
3	Stream flow data ⁺⁺	Hourly or Daily	2012 - current
4	Pan evaporation / evapotranspiration	Daily preferred -OR- weekly or monthly	2012 - current
4	Snow depth, snow water equivalent (SWE)	Daily preferred -OR- weekly or monthly	2012 - current
4	Measured soil moisture	Daily preferred -OR- weekly or monthly	2012 - current
5	Radiation, wind & humidity	Hourly or Daily	2012 - current

⁺⁺ if stream flow data is unavailable, stream stage (height) data plus rating curve may be used.

1.c) Hydrologic Model Calibration – Spatial Data

Priority	Data Type	Resolution	Period of Record
1	Soil type, soil texture, soil depth		
1	Land cover/vegetation cover/ Land use		
2	Stream survey reports / channel geometry information	For small streams, draining < 2000km ²	Surveys within recent 10-15 years
3	Return period flow estimates ^{&}	For small streams, draining < 2000km ²	
4	Spatial coverage of karst regions		

[&] if return period flows are unavailable, stream flow data for 10-20 years may be used to derive these estimates.

(2) ADDITIONAL HISTORICAL DATA (NOT OVERLAPPING SATELLITE ESTIMATES, BUT RECENT TIME PERIOD PREFERRED*

Priority	Data Type	Time Resolution	Period of Record
1	Precipitation	Hourly or Daily	5-20 years
1	Surface air temperature	Hourly or Daily	5-20 years
1	Stream flow data ⁺⁺	Hourly or Daily	5-20 years
2	Pan evaporation / evapotranspiration	Hourly or Daily preferred -OR- weekly or monthly	5-20 years

3	Snow depth, snow water equivalent (SWE)	Daily preferred -OR- weekly or monthly	5-20 years
3	Measured soil moisture	Daily preferred -OR- weekly or monthly	5-20 years
5	Radiation, wind & humidity	Hourly or Daily preferred -OR- weekly or monthly	5-20 years

* *spatial and period of record correspondence between meteorological (P,T,Evap,SWE) and hydrological (Q, soil moisture) observations is desired for hydrologic model calibration. If corresponding time series are unavailable, data is used to evaluate climatological response.*

++ *if stream flow data is unavailable, stream stage (height) data plus rating curve may be used.*

& *if return period flows are unavailable, streamflow data for 10-20 years may be used to derive these estimates.*

(3) ADDITIONAL HISTORICAL STUDIES

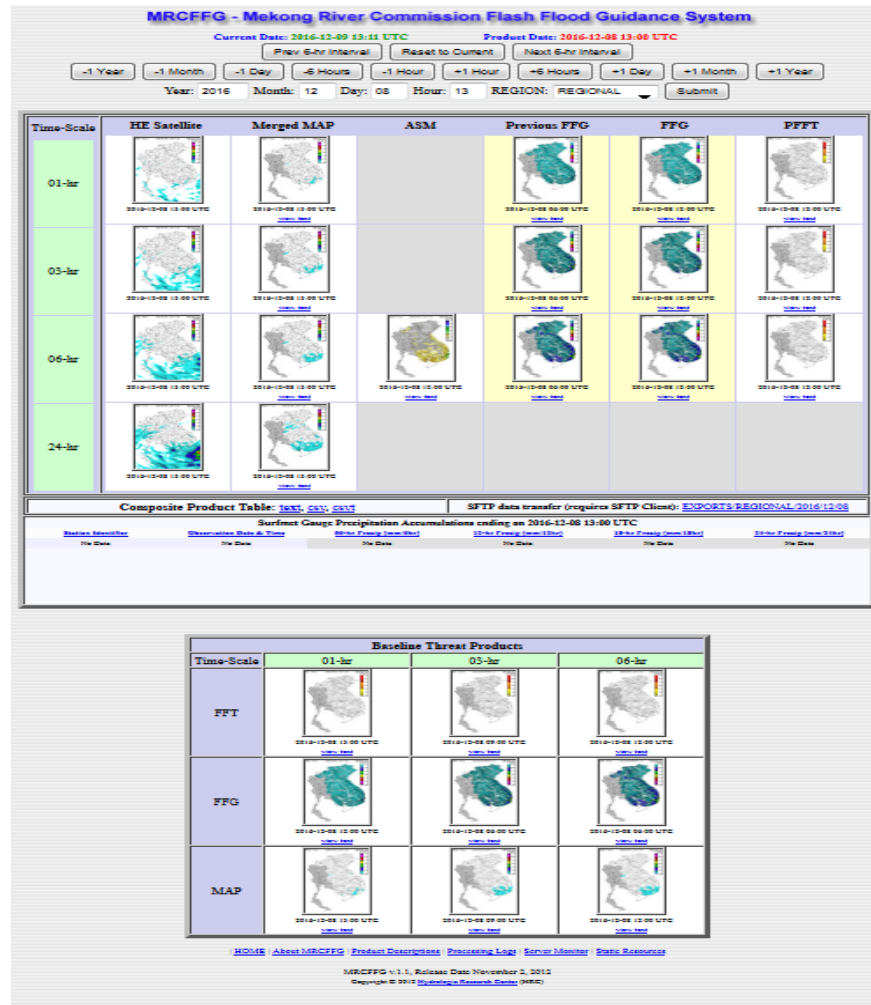
Priority	Data Type	Resolution	Period of Record
4	Location of reservoirs		
4	GIS layers of watershed boundaries or stream network [%]		
5	Historical flash flood occurrences or reports		
6	Flood frequency studies		
6	Karst flow measurements or studies		

[%] *digital GIS layers based on digitization of topographic map preferred and used to evaluate automated watershed delineation results.*

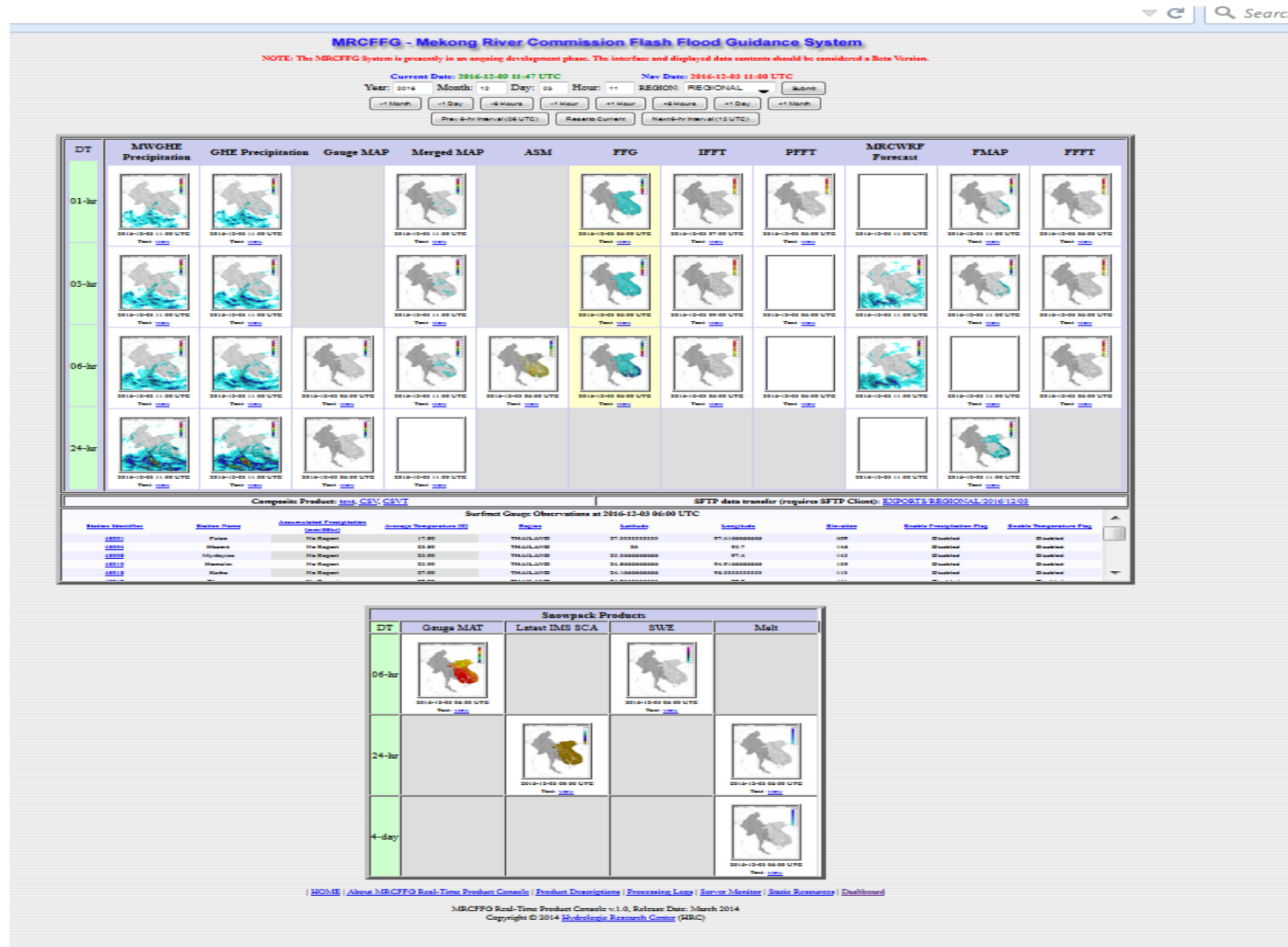
Revised MRCFFGS Implementation Plan

TASK NAME	2016	2017												2018						
		Months												Months						
	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Steering Committee Meeting 1	■																			
Joint MR Committee meeting to discuss submission of LoC and Cooperation agreement with WMO	■	■	■	■																
Letters of commitment (LoC) and points of contact provided to WMO					■	■														
Server Purchase by HRC							■													
Provision of newly available historical hydromet data to HRC through the RC							■													
Complete updated version of the system								■												
On-site system installation at the Regional Center									■											
Complete on-line courses - Step 2 training.							■	■	■											
Provision of real-time data to HRC by the Regional Center and participating countries									■											
Operational training at HRC - Step 3 training										■										
Steering Committee Meeting #2													■							
Follow-up operational workshop (step 4)																■				
Sustainability training (Step 5)																				■

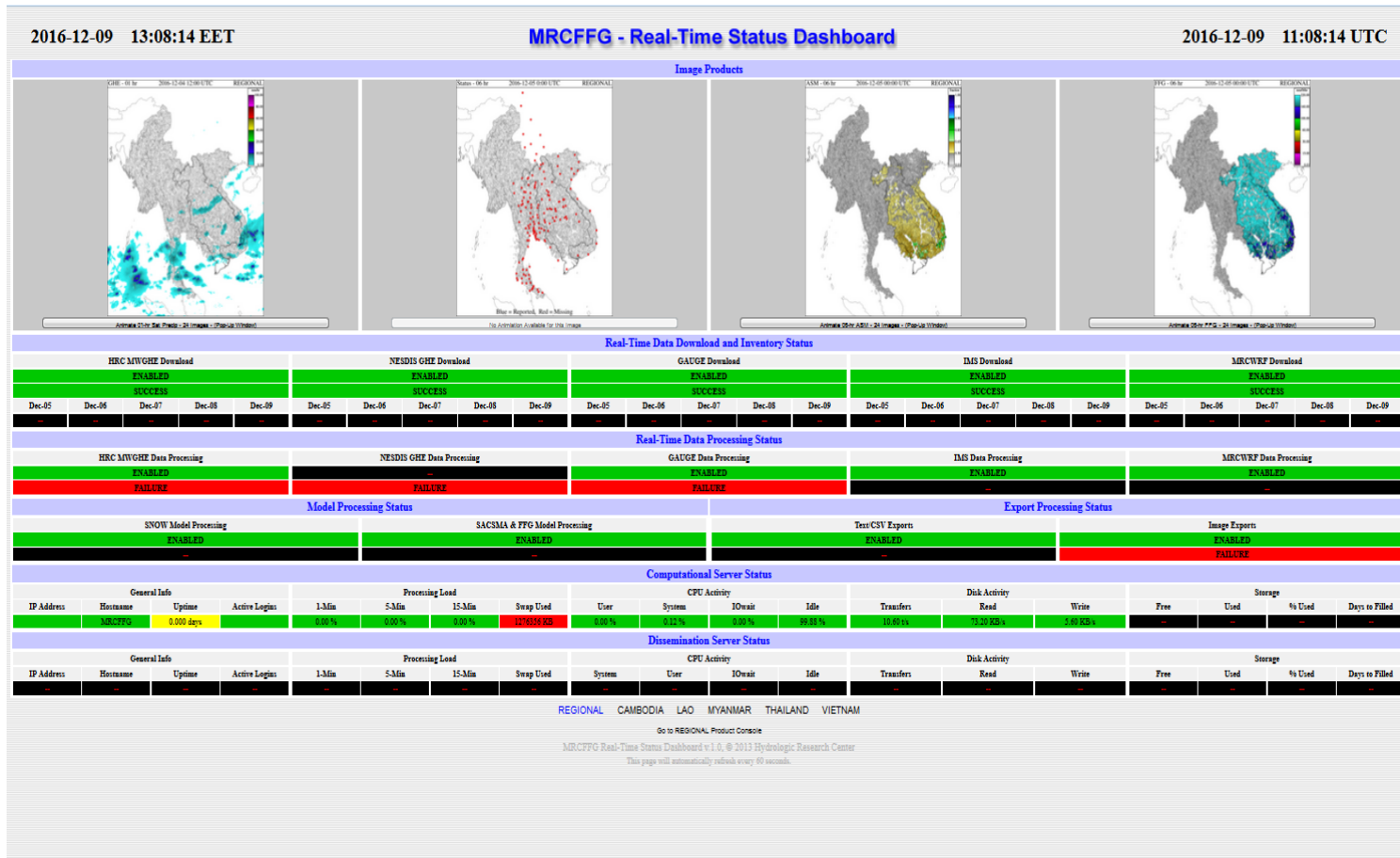
Current MRCFFGS Forecaster Console



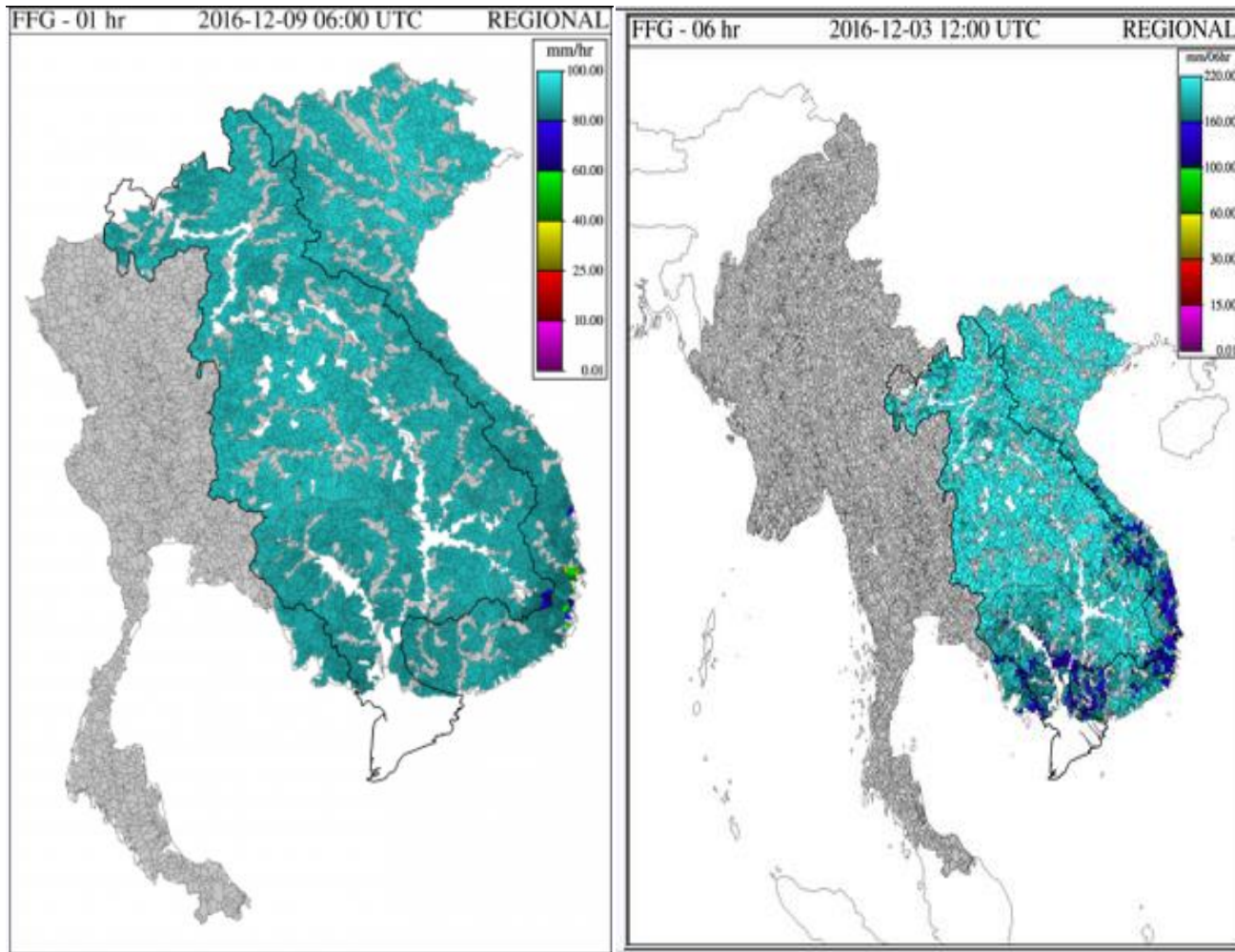
Updated MRCFFGS Forecaster Console

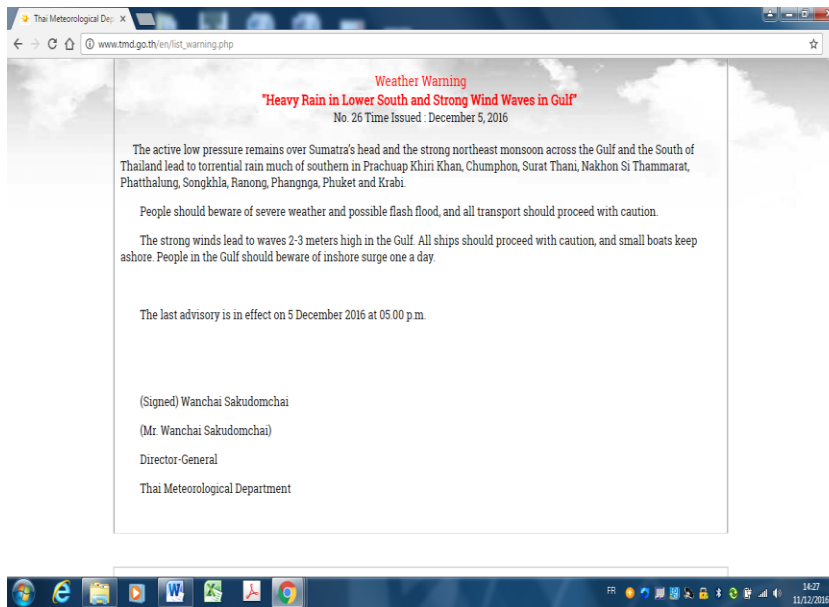


New MRCFFGS Dashboard

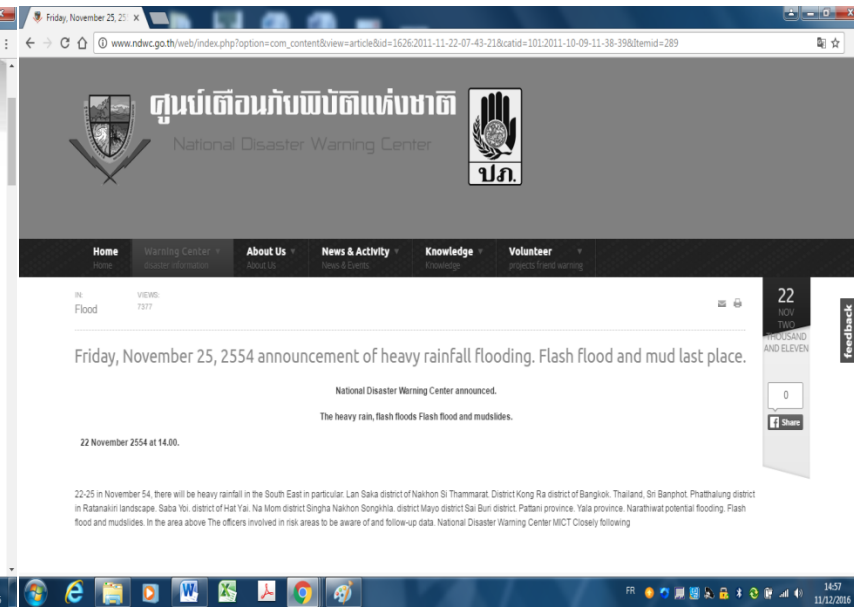


MRCFFGS Product Coverages





Flash Flood Advisory issued by the Tai Meteorological Department.



Flash Flood Warning issued by the National Disaster Warning Center of Thailand.