FOLLOW-UP OPERATIONAL WORKSHOP

SOUTH ASIA REGION FLASH FLOOD GUIDANCE (SAsiaFFG) SYSTEM

New Delhi, India

5 June – 7 June 2018

THE FOLLOW-UP OPERATIONAL WORKSHOP REPORT

July 2018

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Follow-up Operational Workshop of

The South Asia Flash Flood Guidance (SAsiaFFG) Project

New Delhi, India, 5 June – 7 June 2018

1. Executive Summary

In the South Asian region, flash floods account for a significant portion of the lives lost and property damaged from flooding. Flash floods can occur at any time or place leading to disastrous outcomes. This makes it necessary to prioritize efforts that aim at improving early warning capabilities which can in turn help the society to cope with flash flood threats by enabling the mandated national authorities to undertake appropriate measures, thereby, minimizing the losses.

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); United States National Oceanic and Atmospheric Administration (NOAA) National Weather Service (US NWS); the Hydrologic Research Center (HRC), San Diego, and United States Agency for International Development/Office of United States 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 South Asia Flash Flood Guidance (SAsiaFFG) System Initial Planning Meeting was held in Katmandu, Nepal on 26 - 28 November, 2012. Representatives from six South Asian countries, namely, Bangladesh, Bhutan, India, Pakistan, Sri Lanka and Nepal participated in the workshop. The participants expressed their interest to take part in the SAsiaFFG project, highlighting the considerable losses caused to human life and property by the flash floods in the South Asian region. The major outcomes of this meeting were, participants: 1) considered that flash floods were important hydrometeorological hazards in the region and the SAsiaFFG System would help NMHSs mitigate their adverse impacts; 2) agreed on the development and implementation of SAsiaFFG System; 3) Indian Meteorological Department (IMD) were proposed to host the Regional Centres; 4) agreed on the realization of SAsiaFFG System implementation plan; 5) agreed that letters of commitment to be sent to WMO. Subsequently, Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka have submitted LoC to WMO.

Following on the lines of the Initial Planning Meeting, the First Steering Committee Meeting (SCM 1) was successfully conducted in New Delhi, India, from the 26th to the 28th of April 2016. During this meeting, the Indian Meteorological Department was selected as the Regional Centre for Bangladesh, Bhutan, India, Nepal and Sri Lanka. This was followed by a flash flood hydrometeorologist training, operational training at HRC, San Diego from the 5th to the 30th of March, 2018. This training session was attended by two forecasters from Bangladesh, India, Nepal and Sri Lanka and one forecaster from Bhutan.

Based on the SAsiaFFG system implementation plan adopted at the Initial Planning Meeting in Kathmandu, Nepal, the following major project activities have been completed: 1) First

SAsiaFFG system Steering Committee Meeting (SCM 1) took place from 26 to 28 April, 2016 in New Delhi, India; 2) Operational training took place from 5 to 30 March, 2018 at the HRC facilities in San Diego.

As per the implementation plan, the Follow-up Operational Training and Step - 4 training were jointly held in New Delhi, India, from 5 to 7 June, 2018. The objectives of this meeting were to: explore in detail, through presentations and discussions the SAsiaFFG products, their development methodology and review of the technical background, operationally use the SAsiaFFG products through hands-on exercises, review and evaluation of the SAsiaFFG products for elected past events through case studies, performance evaluation of the participants who successfully completed Step 2 and Step 3 training to become a qualified WMO certified trainer.

2. Opening of the Session

During the opening session of the Follow-up Operational Workshop, the representatives of India, WMO, and HRC highlighted the importance of improving the delivery time of flash flood information and guidance to the populations at risk and the need for 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 implementation of technology and scientific approaches undertaken mainly by the countries' NMHSs, 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, Dr. Kanduri Jayaram Ramesh, Director General of the India Meteorological Department and Permanent Representative of India with World Meteorological Organization, emphasized the importance of migrating from rainfall intensity/rain rate forecast services to assessment of flood generating potential of an impending rainfall occurrence at micro-watershed level through the SAsiaFFG system. He also expressed his happiness in collaborating with other South Asian member countries along with the WMO and looked forward to building an effective response system that will have the potential to reduce losses. Dr. Madhavan Nair Rajeevan, Secretary, Ministry of Earth Sciences and Chief Guest of the inaugural function welcomed the participants to the workshop. He emphasized the importance of such workshops in capacity building and improving flash flood forecasting in the region, which is very prone to this hydrometeorological hazards. Mr. Brahma Prakash Yadav, Deputy Director General of Meteorology, Hydrology and Project Director India of FFGS, said that he was pleased to see the progress that was being made for the implementation of SAsiaFFGS project as it would assist capabilities of countries within the region to help cope with flash flood events by enhancing their flash flood early warning capabilities. He also welcomed all participants to the workshop and concluded by saying that he was confident that the workshop would achieve positive outcomes, and looked forward to participating.

Ms. Mutic welcomed everyone on behalf of the WMO and touched upon the objectives of the Follow-up workshop and the intended results. The participants were encouraged to be actively involved in the event by providing their valuable input that will help in shaping this crucial regional Flash Flood Guidance system project. She also thanked the Indian Meteorological Department for their efforts in hosting this workshop and bringing together participants from the various regional NMHSs. Ms. Rochelle Campbell of the HRC welcomed everyone to the workshop and was pleased to see the active participation from the member countries of the

SAsia FFG system. She discussed about the importance of the SAsiaFFG system and on the need for enhancing the capacities of NMHSs of the South Asian countries for effective early warnings of flash floods. She also expressed her appreciation to the Indian Meteorological Department for hosting the follow up workshop.

The workshop was also covered by the national press and the reporters were briefed about the support being provided by WMO for the SAsiaFFG system, the objectives and possible outcomes of the workshop, positive impacts of the project on the citizens of the member countries and enhancement possibilities in the future.

3. Organization of the Follow-up Operational Workshop

The Follow-up Operational Workshop, which was held in New Delhi, India from 5 June to 7 June 2018, was attended by representatives of the NMHSs from Bangladesh, Bhutan, India, Nepal and Sri Lanka. Other participants included representatives from WMO and HRC. The list of participants is provided in Annex 1, while the annotated workshop agenda is given in Annex 2.

4. Proceedings of the Follow-up Operational Workshop

Ms. Mutic provided a brief overview about the purpose of the workshop and highlighted that the main objective of the Flash Flood Guidance System was to build and enhance capacities of the NMHSs to issue warnings and alerts which can help mitigate the adverse impacts of hydrometeorological hazards such as flash floods. The workshop would be an ideal platform for participants of the member countries to present and discuss the needs for flash flood forecasting in the South Asia region. This would also cover the dissemination procedures and coordination between the NMHSs and the Disaster Management Agencies besides fostering regional developments and collaborations and strengthening the WMO Flood Forecasting Initiative.

Ms. Mutic further reiterated the roles and responsibilities of the participating NMHSs and the Regional Centre, wherein, she emphasized that the participating NMHSs have the following responsibilities, inter alia: to provide historical data to the project developer, HRC; to provide in-situ data to the Regional Centre; to participate in the flash flood hydrometeorological training programme; to issue flash flood warnings and disseminate them to their national DMA; and to cooperate with the Regional Centre on the SAsiaFFG system issues. It was cited that the roles and responsibilities of the Regional Centre as inter alia: to communicate effectively with WMO, HRC and NMHSs on the SAsiaFFG system activities; to have computer hardware and software capabilities and good computer network connections; to routinely monitor the availability of the SAsiaFFGS products; and to conduct flash flood variation studies.

Ms. Mutic explained the project implementation status, stressing upon major project milestones. It was highlighted that the following major project activities were completed: 1) Development and implementation of the SAsiaFFG System; 2) First Steering Committee Meeting (SCM1); 3) Operational Training at HRC, San Diego, USA.

She stated that this workshop is one of the major project activities as Step-4 training aimed at: reviewing the SAsiaFFG products to allow forecasters to familiarize themselves with the products; promoting the operational use of the SAsiaFFG products through hands-on exercises; reviewing and evaluating the SAsiaFFG products for the past flash flood events through case studies; evaluating the performance of participants who have successfully completed Step-2 and Step-3 training.

4.1 Status of Operational flash flood forecasting and early warning capabilities in South Asia

The workshop commenced with presentations by the participating members detailing the status of the operational flash flood forecasting systems and early warning capabilities. Mr. S.K. Asok Raja, Scientist with the India Meteorological Department briefed about the existing infrastructure along with the proposed expansions that will boost early warning capabilities of the country. He also gave a timeline of the activities planned for the experimental implementation of the SAsiaFFG system for the 2018 monsoon season in India. Mr. Mohammad Arifuzzaman Bhuyan of the Bangladesh Water Development Board elucidated on the flood warning dissemination modes used in Bangladesh by using an example of a flash flood event that occurred in April, 2017. Mr. Sonam Tashi from the National Center for Hydrology and Meteorology of Bhutan gave an insight into the flood early warning capabilities of Bhutan and also talked about the functions of the various remote monitoring stations. Mr. Bikash Nepal and Mr. Sunil Pokharel from the Department of Hydrology and Meteorology, Nepal outlined the existing flood forecasting system and touched upon the meteorological factors that influence the weather patterns in the country. Examples of actual flood warning dissemination for a rainfall event was illustrated during the course of the presentation. The final presentation was delivered by Mr. Malinda Millangoda from the Department of Meteorology, Sri Lanka and Ms. Suhajinee Gunawardana, from the Department of Irrigation, Sri Lanka. They introduced the audience to the topography and climate of Sri Lanka and gave an overview of their existing flood forecasting system. The presentations by the individual countries gave an insight of the current flood forecasting models and early warning systems in place for each of the member countries. However, it was unanimously agreed upon by all the members that a robust and comprehensive flash flood guidance system such as the SAsia FFGS is instrumental in providing better forecasting capabilities which can reduce the loss to human life and property.

4.2 Overview of the SAsiaFFGS Products and System Operational Concepts

The presentations on the status of operational flash flood forecasting and early warning capabilities in the South Asian member countries was followed by an introduction to the SAsia FFGS. Ms. Campbell gave an overview of the products available to the forecasters. She started with the operational concept and system design, wherein the participants were shown a preview of the product console under the SAsiaFFG system. She highlighted that the goal of the SAsiaFFG system was to provide fully automated data acquisition, ingestion, processing, modelling, with the ability to export the product and dissemination of the information while accommodating various contingencies. This would help reduce the maintenance responsibilities and demand of staff resources, thereby, allowing the forecasters to focus on product interpretation and application.

She described the advantages of the FFGsystem over other models in predicting flash floods. She underlined the impacts that flash flood had on the economic and social lives of the population and addressed how flash floods unlike regular floods was not a hydrological phenomenon but a complex relationship between the local hydrological conditions and meteorological factors. Reiterating on the meteorological factors, she talked about the various mechanisms responsible for triggering rainfall in the South Asia region. She elaborated that factors which indicated how a rainfall event could lead to a flash flood included: 1) slow movement of the system, 2) prolonged heavy-to-intense rainfall rates and 3) areal coverage of intense rainfall rates.

She demonstrated the user interface of the SAsiaFFG system to the participants and stated that the user interfaces are secure web-based interfaces that provide an overview of the system processing status and current and historical products for IT and forecasting personnel. This was ensued by an explanation of the SAsiaFFGS forecaster console with the following main features: 1) navigation toolbars that allow users to display the products at a certain date and time; 2) product table that displays full list of the SAsiaFFGS products in image formats; and 3) data download buttons in text, CSV, and CSVT formats. Subsequently, she gave a breakdown of the following SAsiaFFGS products in detail:

- **Microwave adjusted Global Hydro Estimator (MWGHE) precipitation**, which is estimated by correcting GHE precipitation with Micro wave satellite precipitation.
- **Global Hydro Estimator (GHE) precipitation**, which is produced by the US National Oceanic and Atmospheric Administration (NOAA) using Infrared (IR) channel (10.7 micrometre) of geostationary meteorological satellites.
- Gauge Mean Areal Precipitation (Gauge MAP), which reflects accumulation of basin-average precipitation of a given duration.
- **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.
- **Forecast Mean Areal Precipitation (FMAP)**, which reflects the rainfall accumulations produced using numerical forecasts from the Unified forecast Model of basin-average precipitation.
- **Average Soil Moisture (ASM)**, which indicates upper soil (20-30 cm) water content, including free and tension water.
- **Flash Flood Guidance (FFG)**, 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).
- **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).
- **Gauge Mean Areal Temperature (Gauge MAT)**, which is estimated using in-situ surface temperature observations from the WMO GTS and Global Forecast Systems (GFS).
- **Snow Coverage Area (SCA)**, which is driven by satellite observations.
- **Snow Water Equivalent (SWE)**, which reflects the state of the snow product.
- **Melt Product**, which is the cumulative snowmelt over the last 24 and 96 hours calculated at 6-hour intervals.

She proceeded to explain the general data flow processing design of the SAsiaFFG system which involved input from various components such as satellite precipitation, gauge data, numerical weather prediction models etc. which are then processed and the output is disseminated via a server to various stakeholders such as NHMSs, regional agencies, HRC etc. She also stressed that besides the FFGS system, the forecaster's experiences are equally important for the issuance of flash flood warnings.

4.3 Methodology for Preparation of Flash Flood Warnings

Ms. Mutic provided a detailed methodology which outlined the procedure for the preparation of flash flood warnings. She affirmed that forecasters should do synoptic analysis, mesoscale

analysis and small scale analysis followed by interpretation of the FFGS products. She also addressed the importance of taking into consideration past weather events that could give better images about soil moisture and stage of rivers. For the synoptic analysis, she talked about the forecasting tools and models such as surface charts, 850 hPa and 500 hPa charts. She pointed that the mesoscale analysis should be detailed with focus on local areas while containing detailed surface analysis, dry line, gust fronts, instability and satellite images. The nowcasting analysis as explained by Ms. Mutic is capable of very short forecasting with high spatial resolution. However, the availability of data and tools for better tracking of precipitation, thunderstorms development and movement is crucial for the analysis. In such an analysis, time is very important and every new information or radar/satellite scan can be useful to detect potentially dangerous weather conditions.

She recapitulated the advantages of satellite precipitation estimates as, their high coverage, low latency and high spatial and temporal resolution, which makes them critical in providing valuable information for the regions where ground-based hydrometeorological observations are sparse. However, it was indicated that satellites can over-or-under-estimate precipitation estimates and that forecasters should carefully analyse the satellite precipitation estimate distribution in their particular region. While discussing the Global Hydro Estimator (GHE) precipitation, it was mentioned that three basic assumptions were used for estimating rainfall using infrared data from satellites: 1) cloud-top brightness temperature is inversely related to cloud-top height; 2) cloud-top height is related to the strength of the convective updraft and 3) clouds with stronger updrafts transport moisture upwards more rapidly. She stated that the latency of the data products was around 25 minutes and that they were not bias corrected. While on the other hand, the microwave adjusted GHE provided bias adjusted rainfall estimates from the GHE and that it improved the GHE accuracy.

She continued by describing the Gauge Mean Areal Precipitation (Gauge MAP) product which is generated using synoptic observations that are disseminated through the WMO Global Telecommunication System (GTS). She illustrated the product with an example of a gauge reading from a station forming part of the Southern African Regional Flash Flood Guidance System (SARFFG). This was followed by a description of the Merged Mean Areal Precipitation (Merged MAP) product which provides bias-corrected, best estimates of 1,3,6 and 24-hr precipitation accumulations over each of the FFGS basins. She elucidated the Average Soil Moisture (ASM) through an example of Sri Lanka, where she discussed how the product provided an estimate of the current soil water in the upper soil depth, expressed as a fraction of saturation..

She described the Flash Flood Guidance as the amount of actual rainfall of a given duration that is enough to cause bankfull flow at the outlet of the catchment and advised forecasters to remember that an inverse relationship exists between the possibility of flash flood occurrence and FFG values. While discussing the Flash Flood Threats (FFT), she indicated it as the amount of rainfall of a given duration in excess of the corresponding flash flood guidance value and talked about the different types of FFTs, namely,: 1) Imminent Flash Flood Threat (IFFT), 2) Persistent Flash Flood Threat (PFFT) and 3) Forecast Flash Flood Threat (FFFT). She recommended forecasters to note that Flash Flood Threat is a guide to forecasters for using FFGS products and hydrometerological analysis to decide whether to issue watches or warnings.

4.4 Flash Flood Case Study and Discussions by Participants

As part of the interactive session of the follow up workshop, participants also gave presentations on past flash flood events that occurred in their regions. The presentation was kicked off by Ms. Hemlata Bharwani of the India Meteorological Department, who cited two recent examples of flash floods, which had brought life to a standstill in major cities across India. She showed the various forecaster tools and products from the SAsiaFFG system for the two flash flood events. Mr. Anand Sharma of the India Meteorological Department, gave a presentation on the 2013 flash floods that occurred in Uttarakhand and Himachal Pradesh in India. The event was accentuated by an early arrival of the monsoons over the region and compounded by the orography of the region resulting in extremely intense rainfalls. Thousands of pilgrims and tourists were stranded and a huge rescue operation ensued as a result of the flash floods. Ms. Tahiya Tarannum from the Bangladesh Water Development Board, outlined a flash flood event from last year which had affected several districts in the North Eastern region of Bangladesh. She depicted how a high intensity rainfall event had caused water overflow and embankment breaches in several places and inundated vast areas of croplands. Mr. Sonam Tashi from the National Center for Hydrology and Meteorology, Bhutan reviewed a recent rainfall event in the month of May, 2018 which had triggered flash floods in Phuntsholing and urban flooding in regions adjoining, Thimphu, the capital of Bhutan. Mr. Bikash Nepal from the Department of Hydrology and Meteorology, Nepal gave an insight into the potential flash flood alert that had been generated last year for a catchment area in the country. He described how the Microwave adjusted Global Hydro Estimator and the Global Hydro Estimator product had captured the rainfall event successfully. However, he indicated that the FFT product had failed to predict the outcome for that event and assured to carry out more verifications during the coming monsoon season. Mr. Malinda Millangoda from the Department of Meteorology, Sri Lanka explained how an intense rainfall event in the month of May, 2018 had resulted in flash floods in several districts of the country. This event caused lot of disruption to the daily life and affected over hundred thousand people throughout the region. He illustrated how the FFG system was able to accurately predict the flash flood events in this time period and enable the agencies to issue necessary warnings and carry out evacuations where required. These case studies further strengthened the requirement of a tool such as the SAsiaFFG system and also highlighted the importance of co-operation between the various NMHSs to avoid losses and ensure timely dissemination of warnings.

4.5 Hands-on Exercises

Hands-on exercises of two flash flood events were collectively studied by the participants and were led by Ms. Mutic. Participants used the Flash Flood Guidance System Simulator to interpret the FFGS products for the issuance of flash flood warnings in combination with weather analysis, nowcasting, and local hydrometeorlogical data. The FFGS Simulator had the following features:

- Synoptic (ECMWF) Analysis: Geopotential height 500 hPa, Mean Sea Level Pressure (MSLP), Convective Available Potential Energy (CAPE), 3-hr and 24-hr Quantitative Precipitation; Forecast (QPF), Wind fields;
- Weather Satellite images: RGB air mass analysis, and severe storm RGB;
- FFGS Diagnostic products: Global Hydro Estimator (GHE) precipitation, Micro Wave adjusted Global Hydro Estimator (MWGHE), Gauge Mean Areal Precipitation (Gauge MAP), Merged Mean Areal Precipitation (Merged MAP), Average Soil Moisture (ASM), and Flash Flood Guidance (FFG);

- FFGS Forecast products: Forecasted Mean Areal Precipitation (FMAP) based on WRF NWP model;
- FFGS Warning products: Forecasted Flash Flood Threat (FFFT); and
- Other data such as slope of terrain, soil group, land cover and population density.

Participants discussed the development and propagation of the low pressure centres, troughs, ridges, cold and warm air advections, divergence and convergence fields, and associated weather patterns. After the weather briefing, a facilitated discussion took place among participants who expressed their views on the interpretation of the FFGS products and occurrences of flash floods.

4.6 Verification of flash flood warnings

Ms. Mutic explained the importance of the flash flood warning verification studies. She stated that flash flood warning verification studies are used to understand the uncertainties and limitations of the FFG system. It was mentioned that verification scores and post-event assessments can improve the quality of flash flood warnings. She capitulated that flash flood warnings can be prepared in: 1) Objective methods, which involve the use of FFGS and other models and 2) Subjective methods, that make use of forecaster experience and local knowledge. She briefly explained the method to prepare contingency tables and compute the verification scores such as Probability of Detection (PoD), False Alarm Ratio (FAR), False Alarm Rate (RA), Threat Score (TS), and Frequency Bias (FBI). She presented the verification results for Croatia (SEEFFGS) and Turkey (BSMEFFGS) for the years 2015-16 and 2013-14, respectively. She elaborated on the spatial and temporal distribution of flash flood warnings in both Croatia and Turkey. The participating countries were advised to collect data of flash flood events and conduct verification studies by themselves or in collaboration with the Regional Centre. The results of such studies should be shared with the various stakeholders and partners which can enhance the understanding of flash flood occurrences, their magnitude and geographical distribution, and to improve flash flood forecasting. She concluded by expressing that verification of flash flood warnings is essential for evaluating and improving operational forecast products and for advancing predictability of flash flooding.

4.7 Advances in the FFG System

Ms. Campbell presented the on-going enhancements to the FFG systems and their usefulness in improving the operations. She touched upon the following major topics:

- Multi-model Quantitative Precipitation Forecast (QPF) within FFG systems
- Landslide Susceptibility Mapping and landslide occurrence prediction
- Urban Flash Flood Warning
- Riverine Routing and Discharge Ensemble Prediction.

She articulated each topic saying that it was the forecasters' demand to include multiple mesoscale model input display on the FFGS forecaster console as each model showed different behavior for different seasons and months. She started the topic by showing multiple NWP ingestion examples from the Black Sea Middle East FFGS (BSMEFFGS) and the Central Asia Region FFGS (CARFFGS). She also explained their impacts on the accuracy of the FFGS products. This was followed by an explanation of the landslide susceptibility product which related the susceptibility to landslides based on physical characteristics of land surface. She demonstrated a case study of landslide susceptibility map for El Salvador which was used in the

Central America FFGS (CAFFGS) and extended throughout the region. This includes real-time occurrence prediction based on FFGS rainfall and soil moisture data. She also talked about how the areas were categorized into various classes based on the landslide susceptibility. She then proceeded to discuss the urban flash flood warning which made use of high resolution modelling in urban areas to include both surface and subsurface flow routing. She further elaborated by talking about the demonstration project for the urban flash flood warning system which was carried out for the city of Pretoria, South Africa. She highlighted that similar urban flash flood warning mapping was being done for the cities of Istanbul, Turkey and Jakarta, Indonesia. She concluded her presentation by discussing the riverine routing and ensemble discharge prediction tool which extracted sub-catchment runoff from the FFG system and routed river flow through channel network at high resolution to estimate discharges. She demonstrated this with an example of ensemble discharge prediction for the Panama canal.

During the facilitated discussions, participants affirmed that landslide is a very important hydrometeorlogical hazard in the South Asia region, causing severe loss of human life and extensive damage to property, particularly in the mountainous regions. It was emphasized that water management is also a big concern in the region due to climate variability and change. They unanimously agreed that inclusion of landslide modules into the SAsiaFFG system would improve capabilities of the participating countries to mitigate adverse effects of such hydrometeorological hazards and improve the water management.

4.8 Preparations and Dissemination of Flash Flood Bulletins and Improved Service Delivery

Ms. Mutic delivered a presentation weighing in on the importance of effective flash flood warning systems. She underlined that besides having a robust FFG system, it was essential to ensure timely and effective delivery of flash flood warning to the concerned agencies and to the public in general. Effective warnings should always make use of simple language and shorter sentences. The addition of graphical presentations which uses bold colours and pictures is now being produced by many NMHSs to complement the textual warning. Such warnings should be disseminated via electronic as well as print media. The NMHSs should be flexible in using a variety of platforms such as mobile phones, computers, social networks etc. to deliver the warnings. The automation of the dissemination process would also improve the efficiency and decrease the time required to issue a warning. She went on to add that just dissemination of information would not be useful if the people were not aware of the dangers. She reiterated that public awareness initiatives and campaigns were crucial for ensuring effective flood warning alerts and that the NMHSs should support such initiatives that enhanced the awareness of the general public. User feedback is also essential to make periodic improvements and address the needs of the decision makers. She stated that as per the WMO Guide to public weather services practices, it is acknowledged that warnings were only useful if they were received, understood, believed and acted upon by those at risk.

During the facilitated discussions, participants appreciated the quality of the training and its content, thanking the WMO and HRC for facilitating and providing such excellent training.

5. Conclusions from the Follow-up Operational Workshop

1. There was agreement among participants that the SAsiaFFG System is a useful tool to enable forecasters to issue timely and accurate flash flood warnings in combination with other available tools such as weather analysis and forecasts and nowcasts.

2. Participants understood the responsibilities of the Regional Centre and NHMSs, noting that cooperation and collaboration amongst the project partners is key to the success of the project.

3. Participants agreed that country-level verification studies shall be conducted on the flash flood warnings and FFGS products to improve the performance of the SAsiaFFG System and that a verification guideline should be available to the participating countries.

4. Participants agreed that implementation of advanced modules such as radar ingestion is very beneficial to the NMHSs. They noted the possibility of implementing landslide module and recommended that it should be implemented in the region.

5. Participants noted the necessity of real-time data reception through the GTS to allow real-time bias precipitation adjustment and use of other surface data in model calculations such as surface temperature data ingestion into snow accumulation and ablation model.

6. Participants expressed their appreciation with the availability of the snow products: SWE, MELT, and Snow Coverage Area (SCA) in the SAsiaFFG system. They affirmed that snow accumulation and depletion cause major mountainous hazards such as flooding, and avalanches and that snow is a major water resource in the region.

7. Participants affirmed that flash floods, mudflow, landslide, snow melting, and avalanche are the major mountainous hazards in the region, inflicting heavy economical losses and causing widespread property damages and loss of lives.

8. Participants became familiar with the SAsiaFFGS operational concept.

9. Participants developed competencies to be able to access the SAsiaFFGS servers to use its products.

10. Participants agreed that country-level verification studies shall be conducted on the flash flood warnings and FFGS products to improve the performance of the SAsiaFFG System and that a verification guideline should be available to the participating countries.

11. Participants became familiar with the SAsiaFFGS forecaster console, dashboard, and its products such as Global Hydro Estimator (GHE), Microwave adjusted GHE (MWGHE), gauge Mean Areal Precipitation (GMAP), Merged MAP, Average Soil Moisture (ASM), Flash Flood Guidance (FFG), Flash Flood Threats (FFTs), Forecast Mean Areal Precipitation (FMAP), Snowpack products and Baseline Threat products.

12. Participants developed basic competencies to be able to make synoptic, mesoscale, and nowcasting analysis and interpret the SAsiaFFGS products to prepare flash flood warnings.

13. There was agreement among participants that FFGS Simulator and FFGS quiz are useful tools to train the forecasters.

14. Participants developed basic competencies to prepare clear and understandable flash flood warning messages.

15. Participants developed basic competencies to prepare contingency tables and compute verification scores.

16. Participants who successfully completed Step 2 and Step 3 training took a written exam on the FFGS technical and scientific background and gave a presentation of a flash flood event that took place in their respective countries for obtaining the qualification of WMO certified FFGS Programme trainer.

6. Closing of the Follow-up Operational Workshop

Closing remarks were made by WMO, HRC, India Meteorological Department, and participants. The attendees were thanked for their active participation in the workshop and spirited involvement in the discussions, which contributed to the successful conclusion of the workshop.

ANNEX I




FOLLOW-UP OPERATIONAL WORKSHOP

SOUTH ASIA REGION FLASH FLOOD GUIDANCE (SAsiaFFG) SYSTEM

New Delhi, India

5 June – 7 June 2018

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ANNEX II

Follow-up Operational Workshop of the South Asia Region Flash Flood Guidance (SAsiaFFG) System (Step 4 Training)

New Delhi, India, 5 June – 7 June 2018

Workshop Agenda

Day 1

08:45-09:00	Registration of participants
09:00-09:30	Opening of the workshop (IMD, WMO, HRC)
09:30-09:45	Introduction of participants (All)
09:45-10:15	Overview and Purpose of the Workshop (WMO)
10:15-10:30	Photo Session
10:30-11:00	**Tea Break**
11:00-11:15	Status of Operational flash flood forecasting and early warnings capabilities in India[1]
11:15-11:30	Status of Operational flash flood forecasting and early warnings capabilities in Bangladesh[1]
11:30-11:45	Status of Operational flash flood forecasting and early warnings capabilities in Bhutan[1]
11:45:-12:00	Status of Operational flash flood forecasting and early warnings capabilities in Nepal[1]
12:00-12:15	Status of Operational flash flood forecasting and early warnings capabilities in Sri Lanka[1]

[1] Those who successfully completed step 2 and 3 will make presentations to be evaluated by WMO and HRC to be qualified for the WMO certified FFG trainer.

12:15-12:30 Facilitated discussion on status of operational flash flood forecasting and early warning capabilities in South Asia (All)

12:30-14:00 Lunch Break

Interactive session-participants to be engaged in discussions to demonstrate their comprehension of the system.

14:00-15:00 Overview of SAsiaFFG System Advanced Forecaster User Interface and Review of the SAsiaFFGS Design and Theoretical Background (HRC)

- Review of Satellite Precipitation Estimation and bias adjustment
- Precipitation Observations
- Merged Mean Areal Precipitation
- Average Soil Moisture
- Flash Flood Guidance
- NWP Rainfall Forecasts
- Flash Flood Threats
- Snowpack Products

15:30-16:00 Facilitated discussion on precipitation bias adjustment and associated verification (All)

15:30-16:00 Tea Break

Interactive session-participants to be engaged in discussions to demonstrate their comprehension of the system

16:00-16:30 SAsia FFG System Operational Concept (HRC)

- Computational Server
- Dissemination Server
- Status of RC Operations

16:30-17:00 Facilitated discussions on the SAsiaFFG System products and FFGS Hands-on Quiz (All)

Day 2

09:00-09:30 Review of Day 1

09:30-10:00 How to prepare flash flood warnings: Methodology (WMO)

- Interpretation of weather analysis and forecasts
- Mesoscale and Nowcasting Analysis
- Weather RADAR and Satellite images
- Interpretation of SAsiaFFGS Products

Country-presentations to be provided by those who attended Operational Training at HRC

10:00-10:30 A Flash Flood Case Study and Discussions (India[1])

10:30-11:00 Tea Break

11:00-11:30 A Flash Flood Case Study and Discussions (Bangladesh[2])

11:30-12:00 A Flash Flood Case Study and Discussions (Bhutan[2])

12:00-12:30 A Flash Flood Case Study and Discussions (Nepal[2])

12:30-14:00 Lunch Break

14:00-14:30 A Flash Flood Case Study and Discussions (Sri Lanka[2])

14:30-15:30 Hands-on Exercise for Past Flash Flood Events in the region through FFGS Simulator (Guided by WMO, All) (Example "daily operations")

- Daily Weather Briefing
- Hydrologic Output
- SAsiaFFGS Products Analysis
- Discussion

15:30-16:00 Tea Break

16:30-17:00 Hands-on Exercise for Past Flash Flood Events in the region through FFGS Simulator (Continued)

17:00-17:45 Written Exam[2]

19:00 *Welcome Dinner hosted by India Meteorological Department*

Day 3

09:00-09:30 Review of Day 2

09:30-10:30 Hands-on Exercise for Past Flash Flood Events in the region through FFGS Simulator region (Guided by WMO, All) (Example "daily operations")

- Daily Weather Briefing
- Hydrologic Output
- SAsiaFFGS Product Analysis
- Discussion

[1] Those who successfully completed step 2 and 3 will make presentations to be evaluated by WMO and HRC to be qualified for the WMO certified FFG trainer.

[2] Those who successfully completed step 2 and 3 will take written exam in English to be evaluated by WMO and HRC to be qualified for the WMO certified FFG trainer.

10:30-11:00 Tea Break

11:00-11:30 Hands-on Exercise for Past Flash Flood Events in the region through FFGS Simulator (Continued)

11:30-12:00 FFGS Hands-on Quizzes (Guided by WMO, All)

12:00-13:30 Lunch Break

13:30-14:30 Advances in FFGS (HRC)

14:30-15:00 Preparations and Dissemination of Operational Flash Flood Bulletins and Warnings to Emergency Management Agency (EMA) and How to Improve Service Delivery of Flash Flood Warnings to EMA and Public (WMO)

15:00-15:30 FFGS Hands-on Quizzes (Guided by WMO,All)

15:30-16:00 Tea Break

16:00-16:30 Forecasters Expectations and Recommendations on the Best Use of SAsiaFFG products (All)

16:30-17:00 Sustainability of the SAsiaFFG System: Cooperation with the RC and NMHSs, Universities, Feedbacks, and next steps (All)

17:00-17:30 Final Discussions and Closure (All)

-End of Workshop-