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Flash Flood Guidance Gazette

Flash Flood Guidance (FFG) Gazette, a bi-annual newsletter bringing users of FFG products all the latest news – operational information, technical advances, case studies and education for the flash flood community.

Flash Floods in Croatia – A Case Study of 14th October 2015

As a member of the recently deployed South Eastern Europe Flash Flood Guidance (SEEFFG) system , the Meteorological and Hydrological Service of Croatia has begun operational forecasting, testing and verification of flash flood events. This article examines a recent flash flood event in Croatia utilizing the SEEFFG system.

During 10th - 16th October 2015, Croatia was under the influence of a low pressure system situated over the Gulf of Genoa (see Figure 1). The low pressure system brought moist air into the region and with orographic lifting resulting in heavy rainfall. Daily precipitation in excess of 40 mm/day to 100-130 mm/day was observed at several stations on the 10th and on the 14th of October. Due to steep mountains along the Adriatic coast and in continental closed valleys, this intense rainfall caused flash floods with landslides and extensive property damage.

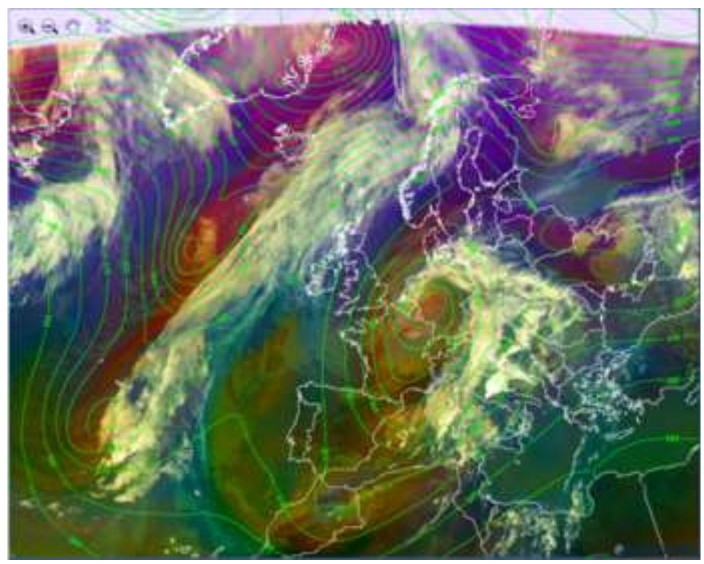

Figure 1. Air mass RGB composite and geopotential height of the pressure level 500 hPa, 14 Oct 2015 at 12:00 UTC

Forecasters at the Croatian Meteorological and Hydrological Service utilized the SEEFFG System to assess conditions in the country during this event. The forecasters considered the FFG system products of average soil moisture (ASM), forecast precipitation (FMAP) from the Aladin forecast model, flash flood guidance (FFG) and the flash flood threat (FFT) products. The forecasters noted high soil moisture saturation on October 13th in the northwestern part of the country, and this high level propagated southern across the mountains and the coast during the event. During the October 14th, 6-hour average soil moisture showed totally saturation of the upper soils in whole coastal and mountainous Croatia (Figure 2). The forecasters' interpretation was that if rainfall continued, it would likely become surface runoff and the situation should be carefully monitored for the possible flash flood occurrences.

The ALADIN forecast and FMAP indicated that the system was stationary and that the rainfall was expected to intensify, reaching values over 120 mm/24 hr (locally over 160 mm/ 24 hr).

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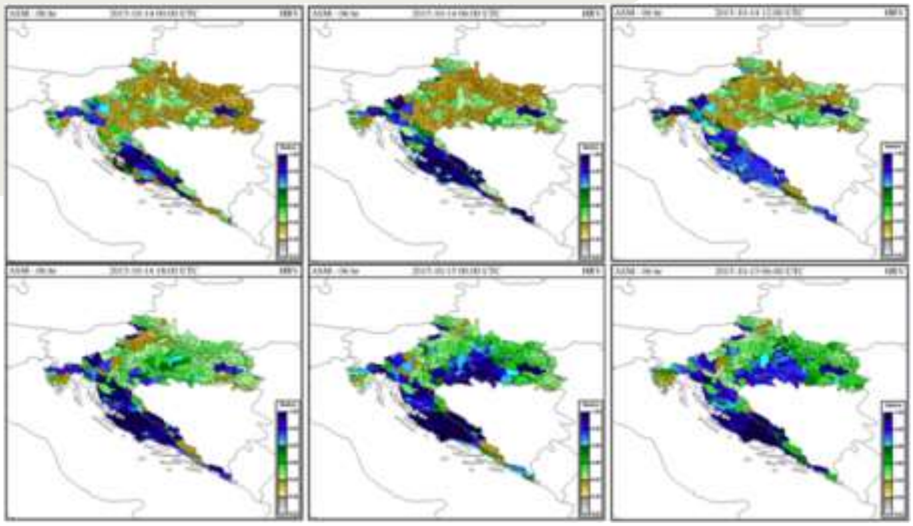

Figure 2. Temporal and spatial distribution of average soil moisture

The FFG estimates were very low (10-25mm/hr) for many sub-basins in the southern and coastal regions. Thus, the system generated forecast threat products indicated positive values and possibility of flash flood occurrence in the mountainous region to the southern coast. Using their knowledge and local information, the forecasters further included local adjustments in assessment of the potential for flash flood occurrence.

The Croatian Meteorological and Hydrological Service issued several flash flood warnings to the National Protection and Rescue Directorate (NPRD) and also via Meteoalarm to the public and media during the event. Post-event assessment indicated a probability of detection of 90% and a probability of a false alarm of 10% . The affected area is Dinaric karst, Croatian media and NPRD all reported flash flood events. In addition, approximately 100 landslides occurred during this event. Infrastructure was flooded, roads and vents were damaged but fortunately there were not any human losses.

This case study indicates accurate forecasts and warnings during this event. However, Croatia needs more effective action strategies. Because time is the most critical factor, collaboration and involvement is necessary for effective "end-to-end" flash flood forecasting and warning system. The SEEFFG System proved valuable for disseminating warnings in Croatia, and highlighted a great opportunity for enhancement of collaboration with response agencies in disaster risk reduction and raising community awareness.

Figure 3. Flash floods along the coastal Croatia on October 14th, 2015

**Contributors, Petra Mutic and Toni Jurlina,
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FLASH FLOOD EVENT IN SHIPKOVICA, MACEDONIA - 3RD AUGUST 2015

Upon completing the operational training on the South Eastern Europe Flash Flood Guidance (SEEFFG) system in San Diego, I returned to Macedonia to news reports of a flash flood event near Shipkovica, in the northern part of the country. Flash flood events in Macedonia can be quite destructive as the water scours the waterway bed and shore, making a mixture of sand, rock, and mud which travels swiftly downstream and causes damage along its path. The high water flood wave of flash floods causes much damage in Macedonia, particularly when the flash floods occur in normally low water or dry ravines.

Following heavy rains, flash flooding occurred on the 3rd of August in the Tetovo region of Macedonia. Several villages and the city of Tetovo were impacted with severe losses. Six people lost their lives in the flash flood, with four of them being young children. Damage was also done to infrastructure and housing. The region of Shipkovica was hit hardest.

The village of Shipkovica is located on the slope of the Sar Planina mountain in northern Macedonia. According to witnesses, the rain started around 15:00 local time (13:00 UTC), as a normal or common rainfall. However, it progressed into precipitation with strong intensity for approximately an hour. At 17:30 (15:30 UTC), water started to flow through the gully in the middle of the village. After only 10-15 minutes, large amount of dirt, sand and stones were being carried by the water, and were crashing between and through the houses. The flood wave passed through the village. The flow in the gully subsided at 18:00 (16:00 UTC), leaving much devastation as shown in the figures.

Figure 1. Damaged houses in Shipkovica

The size of the catchment draining to Shipkovica is small, less than 2 km^2. The adjacent catchment to Shipkovica is named Golem Poroj. It is larger, with a drainage area of 2.35 km^2, and it was also hit by the same heavy rain. The flow through Golem Poroj was estimated to be higher, but the water course does not pass through settlements, and the flash flood damaged only part of the nearby forest. The last known flash flood with similar power in this region happened in 1935, also with several fatalities.

Prediction for heavy rain in the northern part of Macedonia was done in advance, but it was difficult to predict exact location of the flash flood. For the region of Tetovo, there is currently only one meteorological station situated in the town. The next morning after the flooding, only 9 mm of rainfall was measured over the previous 24 hours at this station. This highlights the fact that gauge measurements are not enough to observe areal precipitation amounts in the case of flash floods and satellite information is necessary. After visiting flooded sites and observing the flood damage, preliminary calculations suggest that the rainfall intensity was around 60-90 mm for a period of 1-3 hours, and the maximum flood wave size which passed through Shipkovica was about 10-15 m^3/s.

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FLASH FLOOD EVENT IN SHIPKOVICA, MACEDONIA - 3RD AUGUST 2015

After this event, I reviewed the event through the SEEFFG System. The satellite observations of precipitation (gridded GHE) indicated heavier precipitation of up to 40 mm/6-hr in the central to north-central part of Macedonia at 15:00 UTC. Heavy rain was also indicated to the southwest and into Greece. The heavier precipitation was to the south of the Sar Planina mountain. Soil moisture conditions as indicated by the FFG system were fairly low throughout Macedonia prior to the event (12:00 UTC) but changed quickly to high saturation for some basins by 18:00 UTC. The FFG values were low for several basins to the south of the Sar Planina mountain (for example, as low as 25 mm/3-hr), and on the order of 25-40 mm/3-hr for the region of Shipkovica. The forecast of precipitation within the System indicated numerous heavier rainfall throughout Macedonia, with highest rates of 40-50 mm/3-hr, but located further south of the Shipkovica region, and 20 mm/3-hr in the region. The flash flood basins in the north of Macedonia showed very low FFG values (order of 10-15 mm/3-hr) at the end of the event at 18:00 UTC. Knowledge of local conditions and the location of heavy precipitation (both observed and forecast) were critical in assessing the situation for this event.

Although flash flood events are difficult to predict to in Macedonia, I believe that the FFG system may provide some hope to avoid future catastrophes.

Contributor Vasko Stojov, Head of Department in Sector of Hydrology, National Hydrometeorological Service, Republic of Macedonia

SEEFFG Operational Training Course at HRC, San Diego, 6-31 July 2015

The Flash Flood Guidance (FFG) Training for the participants from South Eastern Europe was organized by the Hydrological Research Centre (HRC) from San Diego and supported by the World Meteorological Organization (WMO). Experts from the regional hydrological and meteorological services of Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Macedonia, Albania and Moldova attended the 4-week training course at the HRC offices in San Diego, California. In addition, there were representatives from the Turkish State Meteorological Service and the Jordanian meteorological service. The training focused at successful integration of the South Eastern Europe Flash Flood Guidance (SEEFFG) System into the regional flash flood detection and forecasting practices through (a) basic technical knowledge of the system, (b) operational usage of system products, and (c) incorporation of regional expertise, knowledge and data in application of the system.

The training course featured wide scope of topics from the fields of meteorology, hydrology, remote sensing and GIS. The range of topics provided the participants with enough background for understanding the FFG system concept and evaluation of its results. During the course, the participants acquired practical experiences with the SEEFFG operational system, its graphical interface and products. A portion of the training course was dedicated to sharing of local knowledge, practices and experiences with emphasis on flash flood forecasting and warning processes. Throughout the course and the related activities, the participants could discuss their understanding of the SEEFFG system and hence consolidate the acquired knowledge. The participants also provided detailed suggestions to the system developers on the catchment delineation and presence of karst features in the region, the quality of the regional soil, precipitation and air temperature data sets available in the global databases, etc.

The comprehensive training course and the related activities left the participants with a very good impression. The visit to the National Weather Service in San Diego was a unique opportunity for the participants to get an insight into the procedures, practices and tools in the world's most advanced and well-organized meteorological service. Overall, greatest outcome of the training course are the strengthened regional community of hydro-meteorologists and the established links among the participants and the trainers.

Contributors
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Figure 1. South East Europe trainees and HRC staff

HRC Partners with International Organization for Migration (IOM) in Haiti to Optimize Community-Scale Flood Mitigation Efforts

The Hydrologic Research Center partnered with the International Organization for Migration (IOM), to aid Haitian partners in optimizing their efforts to minimize the flooding hazard in Petionville, Port-au-Prince, Haiti. IOM partners have installed several gabion check dams and done revegetation projects, both inside the ephemeral ravine bottoms and on the watershed hillslopes. Understanding the relative impact of different activities is essential to maximizing the impacts of limited resources.

Working in partnership, IOM and HRC gathered the necessary data to build numerical representations of the watershed and channel geometries (Figure 1). This data was then used to build a hydrologic model to estimate runoff and assess the impact of land use and vegetation changes to watershed runoff, including the time to peak of the rain event and the magnitude and duration of peak flows. A hydraulic model was also built and used to estimate the impact of gabion dams and revegetation efforts in ephemeral ravines, also with respect to the timing, duration, and magnitude of peak flows.

The results from these modeling efforts can be used to develop an understanding of the cost-benefit ratio of each watershed or ravine treatment. Along with aiding IOM partners in Haiti in this one ravine system. This methodology is in the process of being developed into a guidebook to be used by watershed managers around the world in establishing their own local-scale flood mitigation and watershed restoration efforts.

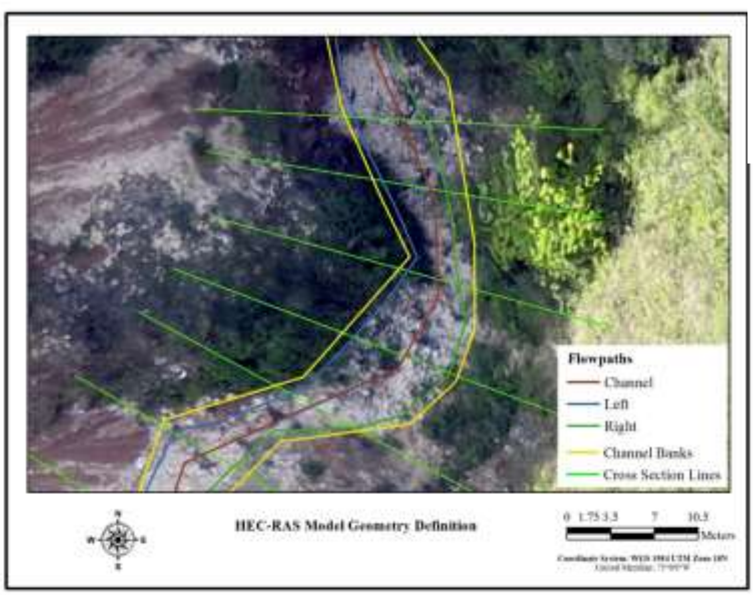

Figure 1. Hi– resolution numerical representations of the watershed and channel geometries.

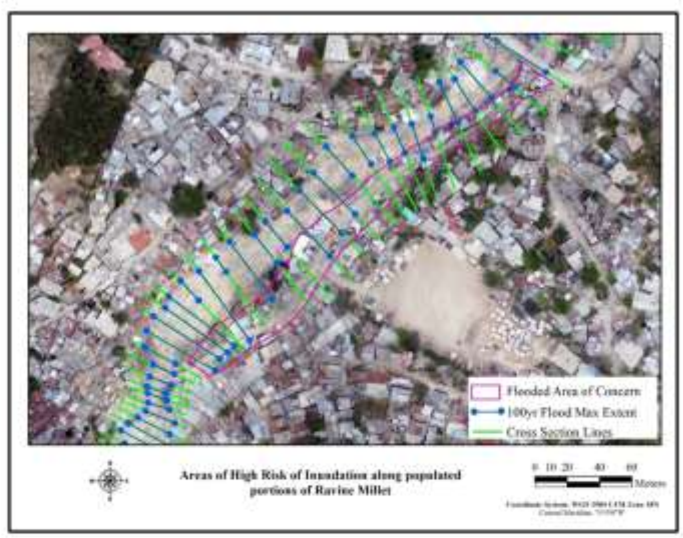

Figure 2. Areas of High Risk of Inundation along populated portions of Ravine Millet

Contributor Ari Posner, Hydrologic Research Center

FLASH FLOOD SITUATION IN SWAZILAND

Flash flooding is a silent killer in Swaziland, primarily because of the diverse climate and topogrpahy of the country. In Swaziland flash floods are experienced annually, with the worst taking place in 2012 where both lives and properties were destroyed in Mbabane City.

The country has taken an initiative to deal with flash flooding by participating in the recent (September 2015) South Africa Region Flash Flood Guidance (SARFFG) system advanced operations training workshop held at the Hydrologic Research Center in San Diego, California USA. Swaziland also participated in the Twinning workshop of SARFFG and Severe Weather Forecast Demonstration Project (SWFDP) recently held in Pretoria, South Africa. This demonstrates Swaziland has recognised the impacts of flash floods, and is willing to do its best to reduce their impact.

Figures 1 and 2. Flash floods in Swaziland

The SARFFG system is a new programme for Swaziland and a lot of training is essential for Forecasters, hydrologists and other stake holders such as Disaster Management Agencies, Media, NGOs and the public in general. Also, more exposure is essential for the trained forecasters (in the form of visiting other countries who already use the system).

In conclusion, let me confess that SARFFG system is the best tool in many ways to many stake holders. The satellite data (MWGHE&GHE), the soil moisture (ASM), the flash flood guidance (FFG) and the forecasted precipitation (FMAP) are essential products to farmers, construction companies, surveyors and many others. I can assure you that we shall use this tool in our country.

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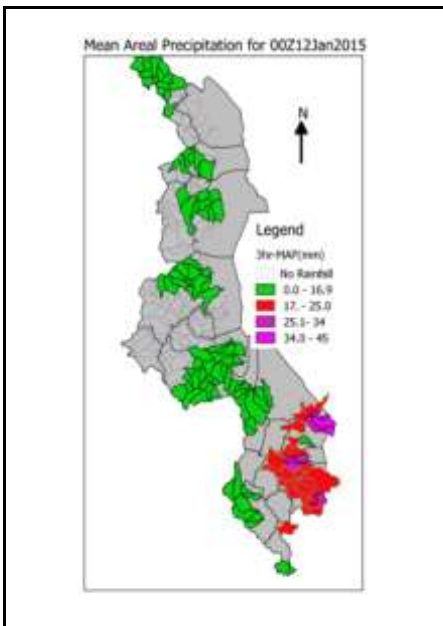
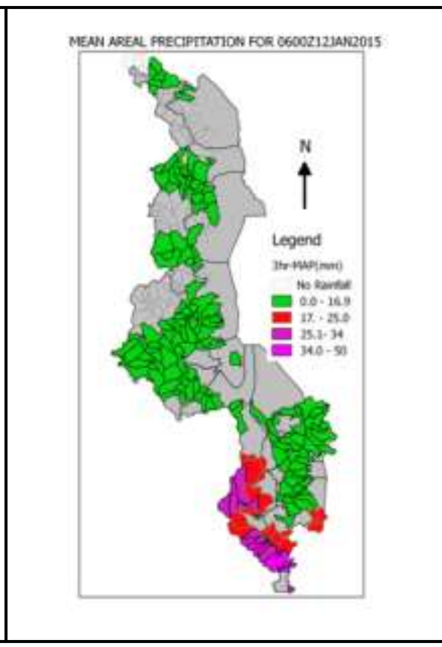
Reducing Local Losses from FLASH FLOODING through Regional Implementation of EARLY WARNING SYSTEMS having Global Coverage: A Case Study from January 2015 Flash Floods in Malawi

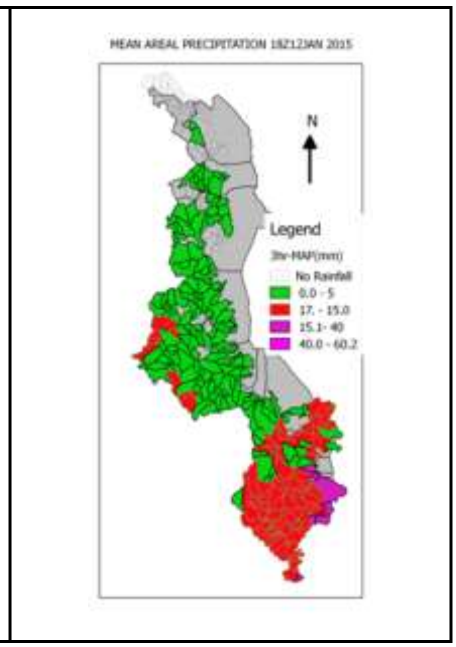
Tropical convective storms and cyclones are becoming both stronger and more frequent in Malawi, containing stronger winds and heavier rains. In Malawi, this has resulted in flash flood events that annually produce the most fatalities, severe damage to property and infrastructure of all natural hazards. In January 2015, thunderstorms resulted in flash flood events that were the worst in decades.

Initially an area of thunderstorms with heavy rains, developed on 9th January within the intertropical convergence zone between the coast of Mozambique and the Mozambique Channel. These storms moved, generally westward toward Malawi. As a result most areas in southern Malawi experienced heavy rains which saturated the soils. The situation became critical in the night of 12th January when a low pressure system formed over the Mozambique Channel and continued to deepen. This system caused heavy rain over much of Malawi, especially in the southern regions of the country with serious flash flooding. The heavy rainfalls can be seen in Figures 1 -3. These figures are outputs SARFFG system and provide three-hour accumulations of mean areal precipitation in millimetres over catchments at 00, 06, and 18 UTC on 12 January. These figures show the heavier rainfalls to the south of the country.

The Department of Climate Change and Meteorological Services (DCCMS) monitored the situation with the aid of the SARFFG System. The SARFFG uses the flash flood guidance approach to assist forecasters in developing flash flood warnings and relies on the real-time comparison of observed or forecast rainfall volume of a given duration and over a given catchment to a characteristic volume of rainfall for that duration and catchment that generates bank full flow conditions at the catchment outlet. If the observed or forecast rainfall volume is greater than the characteristic rainfall volume then flooding in the catchment is likely. The characteristic rainfall volume for a particular catchment and duration, called "flash flood guidance", depends on the catchment and drainage network characteristics, and the soil water deficit determined by antecedent rainfall, evapotranspiration and groundwater loss.







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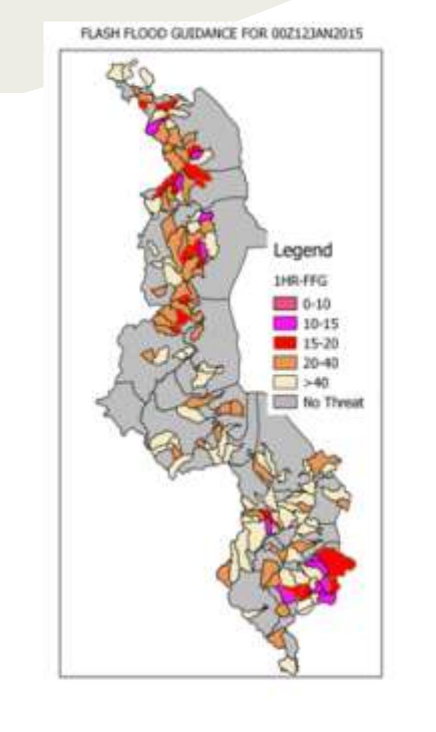

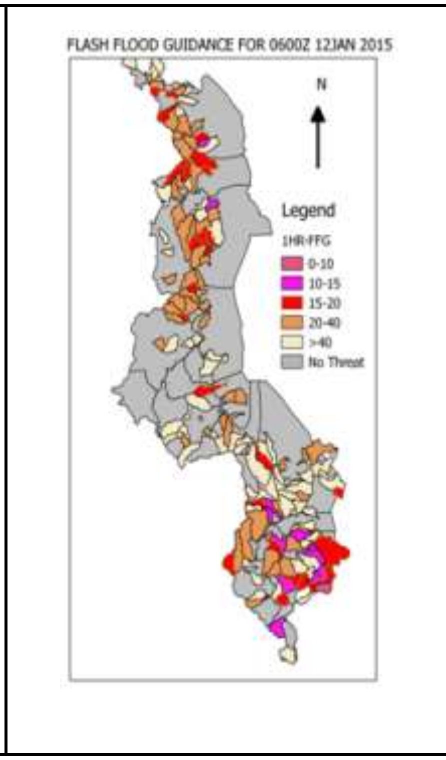

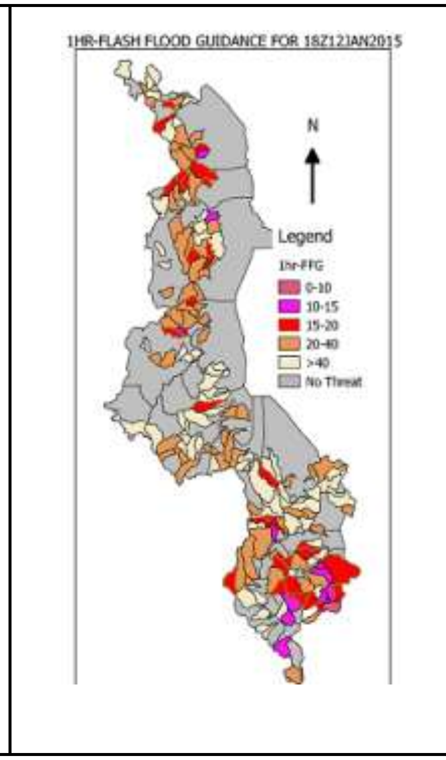

One hour flash flood guidance values are shown in Figures 4-6 also for 12 January at 00, 06, and 18 UTC. The lower values of flash flood guidance (reds and purple) indicate catchments are most vulnerable to flash floods, as little rainfall is needed to cause bank full flow.

The Department of Climate Change and Meteorological Services monitored and issued flash flood warnings continuously through both print and electronic media, on the DCCMS website (www.metmalawi.com).

An example of the warnings is below:

"Take note that we still have low FFG values marked RED in Northern Malawi. This translates to high risk of flash flooding if 0.01 to 30mm in the next 6 hours is attained in those areas. We expect the southern areas to pick the low FFG signal in the next 24 hours as a low pressure area deepens in the Mozambique Channel to enhance Congo air mass over most areas of Malawi. Monitoring of flash floods continues." The DCCMS worked closely with the Department of Disaster Management Affairs (DoDMA) through the worst disaster in decades, affecting millions of Malawians in 15 out of 28 Districts (Figure 7). The January 2015 riverine floods and flash floods introduced the Malawi citizenry to the importance of adhering to and making use of the flash flood warnings and messages. The DCCMS timely flash flood forecasts and warnings from SARFFG systems reduced casualties, damage to properties, and enhance public preparedness.

Contributors Charles Langton Vanya, Yobu Ezra Kachiwanda, Department of Climate Change and Meteorological Services, Malawi

Southeastern Asia-Oceania Flash Flood Guidance Workshop

Southeastern Asia-Oceania Flash Flood Guidance system (SAOFFG) inital planning workshop was held in Jakarta, Indonesia on the 2nd to 4th February, 2016. The workshop is the result of cooperation between World Meteorological Organization (WMO), Hydrologic Research Center (HRC), National Oceanic and Atmospheric Administration (NOAA), United States Agency for International Development (USAID) and Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG). The development of the SAOFFG system in the region aims to contribute to reducing the vulnerability of the region to hydometeorologic hazards, such as flash floods.

The initial planing workshop is an introduction to the technology and design of philosophy of the Global Flash Flood Guidance program that bring the countries in the region together for enhanced cooperation. The participants discussed the need for the prediction of flash floods, including procedures for dissemination of early warnings and the coordination between national meteorological and hydrological services and disaster risk management.

The main objective of the Global Flash Flood Guidance program is to develop and implement regional flash flood guidance systems to strengthen thecountries capacity to develop timely and accurate flash flood warnings and reduce societal vulnerability.

Figure 1 and 2 . Participants of SAOFFG meeting visiting Meteorological Services at BMKG.