DELIVERY OF WARINGS OF HYDROMETEOROLOGICAL HAZARDS – SOUTHERN AFRICAN REGION

Regional Technical Meeting and User/CONOPS Workshop

Pretoria, South Africa 26-30 October 2015

FINAL REPORT

1 December 2015

TABLE OF CONTENTS

1. Introduction and Welcome

In 2009, the Memorandum of Understanding among WMO, US National Weather Service, USAID/OFDA, and the US Hydrologic Research Center was signed with the purpose of facilitating the implementation of the Flash Flood Guidance System (FFGS) project with global coverage. Under this instrument, the Southern African Region Flash Flood Guidance System (SARFFGS) was implemented, with RSMC Pretoria acting as its Regional Centre. Coincident with these efforts, the Southern Africa Severe Weather Forecasting Development Project (SWFDP-SA) was also developed and implemented. In early 2015, the partners agreed to undertake an additional project that would enhance inter-system linkages to improve accuracy, lead time, communication and dissemination of early warnings of extreme hydrometeorological hazards with appropriate lead times to reduce loss of lives and protect livelihoods and property and the environment in Southern African Region. A Project Brief was developed outlining the various project objectives and outlining in detail important aspects of the project including activities. The overall plan called for two events, namely a Regional Technical Meeting to initiative the development of the system integration implementation plan, also referred to as a Roadmap, and the User/CONOPS Workshop. This second event was designed to obtain Disaster Risk Reduction user community input on warning requirements that are needed to promote and allow effective responses to be taken. The second aspect of this meeting was to begin the process of developing Concept of Operations Plans (CONOPS) for integrating programme linkages between the two systems. The Project Brief is contained in **Annex I**.

The Regional Technical Meeting was held on October 26-27 and back-to-back with the User/CONOPS Workshop, which was held 28-30 October 2015 in Pretoria, South Africa. Both events were hosted by the South African Weather Service and were attended by experts from the National Meteorological and Hydrological Services (NMHSs) of the countries participating in the South African Region Flash Flood Guidance (SARFFG) project. One expert from each participating country's disaster management agency was also invited to participate on 28 October 2015. The list of participants is attached as **Annex II**. The agenda for the two events is attached as **Annex III**.

MrEugene Poolman, Chief Forecaster Disaster Risk Reduction, on behalf of the Permanent Representative for WMO to South Africa, Dr Linda Makuleni, welcomed participants to the events and to South Africa. MrAbdoulayeHarou, Chief, Data Processing and Forecasting System, WMO, welcomed participants on behalf of the Secretary-General, Mr Michel Jarraud, and highlighted the fact that the SWFDP started in South Africa in 2007. He noted that it was the only SWFDP initiative that has reached Phase IV, namely being an automatous operation. He also underlined that the synergy between the SWFDP-SA and the SARFFGS represent significant advances in increasing the capacity to provide early warnings of hydrometeorological hazards. He encouraged the participants to share their views and to interact in these two important events, as the intent of these efforts is to pioneer the development of the interaction between the systems that would be useful to other regional applications.He also took the opportunity of thanking South Africa for hosting the two events. Mr Curt Barrett (USAID/OFDA) also thanked South Africa for hosting the event, and he underlined the importance of the project. He indicated that USAID/OFDA was pleased to help in building the synergies between the two systems and is committed to the success of this project. USAID/OFDA believes that this project will contribute to improved performance of the participating countries early warning systems resulting in reduction in loss of life and property damages.

2. Meeting and Workshop Objectives

Messrs Paul Pilon (WMO) andCurt Barrett (USAID/OFDA) provided a presentation outlining the project objectives, as well as the purposes and expected outcomes from the two events. The project objectives were given as:

- Integrating the Severe Weather Forecasting Demonstration Project Southern Africa (SWFDP-SA)and Southern African Region Flash Flood Guidance System (SARFFGS) programmes to improve forecasting of severe hydrometeorological events by National Meteorological and Hydrological Services (NMHSs);

- Linking the SWFDP-SA and SARFFG systems to enhance user interfaces and expand the suite of products available to forecasters using the systems;

- Strengthening the capacity of NMHSs to provide timely and effective early warnings of extreme hydrometeorologicalhazards with appropriate lead times for taking action; and

- Developing products and information that addresses needs of users such as National Disaster Management Agencies, NGOs, UN and general public to reduce loss of lives and livelihoods and to protect property and the environment in the Southern Africa region due to extreme hydrometeorological events.

The purposes of the two events were given as:

- Introducing to participating country experts the Integration Project on bridging andenhancing the two systems capabilities, by bringing experts together to review system architecture and to further develop and agree upon the system integration implementation plan (also referred to as the Roadmap) for both the national and regional levels;

- Establishing rapport with the disaster risk reduction user community seeking their input on warning requirements and their perceived value of decisionsupport tools and products that are needed to achieve effective responses;

- Beginning the process of developing Concept of Operations Plans (CONOPS) for theintegrated programmes linking the systems within each country and at the regional level;

- Developing an increased understanding amongst participants of the capabilities and capacities of NMHSs and their users' needs and requirements for early warnings for extreme hydrometeorological hazards;

- Obtaining feedback on potential new and enhanced features of the SARFFG Forecaster User Interface including user-defined layers (e.g., terrain, political boundaries, roads, building locations, etc.);

- Commencing the initial development of a roadmap (framework) to integrate the SWFDP and SARFFG projects to improve interfaces/products/information from both projects to strengthen the capacities of NMHS to better support their users for early warnings of hydrometeorological hazards; and

- Commencing the preparation of a draft Concept of Operations Plan document for each country and the regional centrethat outlines the application of the integrated and linked SWFDP-SA and SARFFG systems into their forecast and warning operations.

3. Achieving the End-to-End Forecasting and Warning System

MrCurt Barrett introduced the concept of a series of interlinked activities that hedescribed as the end-to-end forecasting and warning system. He indicated that the activities could be thought of as links in a chain, with the strength of the chain being dependent on its weakest link. He provided Figure 1 as a schematic illustrating the main activities and how they form a sequential chain of activities that flow from data acquisition through forecast production and dissemination to users to society taking actions that allow reduction in losses to occur from the occurrence of the forecasted extreme hydrometeorologicalhazard. He emphasized the importance of the Roadmap and CONOPS documents as being important in supporting the implementation of an effective, operational early warning system.

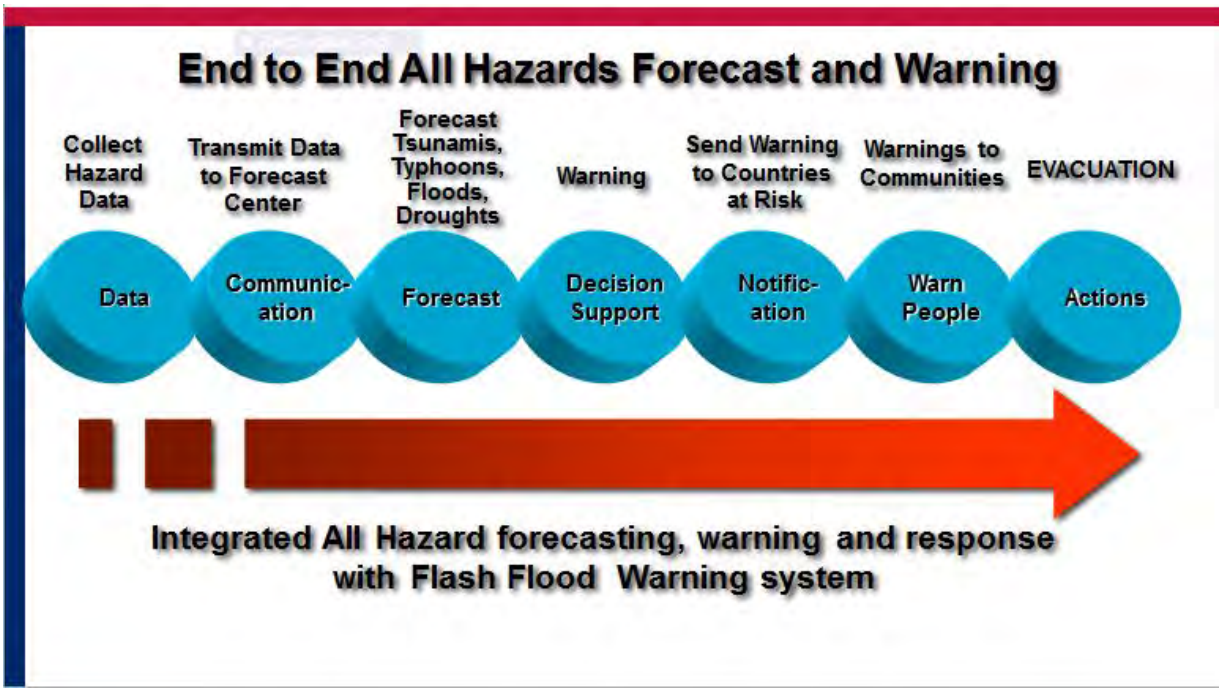

Figure 1: Schematic illustrating the sequence of activities necessary to allow effective early warnings of hydrometeorological hazards.

4. New Product Considerations for the Integrated System

Presentations[1] were given providing an overview of the SWFDP and SARFFG initiatives by MessrsAbdoulayeHarou, Eugene Poolmanand Robert Jubach. These presentations allowed participants to understand the current capabilities and deployment of both systems in the southern African region. Building on their current capabilities, Messrs Robert Jubach (HRC) and Eugene Poolman (SAWS) gave presentations of potential additional products for the SARFFG and the SWFDP systems for consideration of participants.

[1] All presentations made during the two events can be downloaded from the WMO website, under water and its Hydrology and Water Resources Programme under Hydrological Forecasting and Prediction: see http://www.wmo.int/pages/prog/hwrp/flood/ffgs/meetings/pretoria2015.php

The SARFFG proposals included: an upgrade to the forecaster interface, where work is already underway; the addition of a flash flood risk component; and the addition of a riverine routing component, taking advantage of all the modeling undertaken at the small basin scale and linked similar to the semi-distributed hydrological modeling approach. All these SARFFG additions would use currently functional capabilities and data available within the system.

The proposed upgrade to the forecaster interface includes:

- Viewing the current SARFFG system products over a variety of user-defined layers such as:
    - Terrain
    - Political/Administrative Boundaries
    - Roads
    - Cities
- Interactive capability to allow scrolling and zooming
- Point and click data interrogation (e.g., access numerical data and time series displays).

Figure 2 provides an example of a zoomed precipitation product overlaid with roads and cities plus basin precipitation values. It was indicated that such a product allowed forecasters and users to more easily identify where heavy precipitation and flash flooding may be occurring.

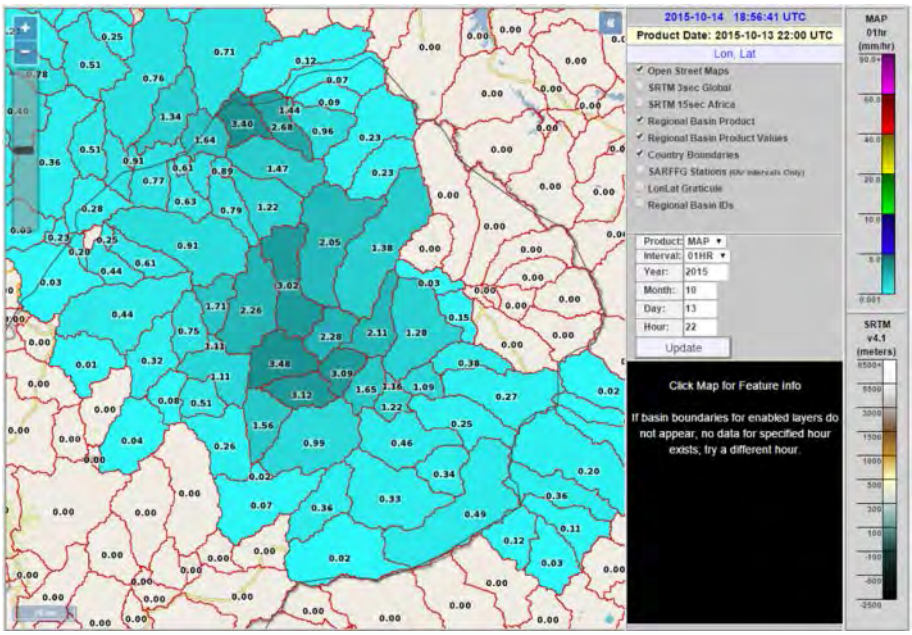

Figure 2: Example of user defined overlays on modelled area.

The flash flood risk component uses the available mesoscalenumerical weather prediction model quantitative precipitation forecast (QPF) product to create a flash flood probability by

basin for forecast lead times of 12, 24, and 36 hours. The probability is based on the number of forecasted flash flood occurrences (for 1, 3, or 6 hours). It was mentioned that this type of product, an example of which is shown in Figure 3, could be used to look at future flash flood potential for products such as flash flood watches. During discussion on this new product, participants mentioned that it would be useful if the SARFFG system would be able to adjust rainfall estimates and forecasts by a user specified scalar value (i.e., increase or decrease the field by x %). For example, an increase of 50% or a decrease of 50% would be applied to allow the user to see the sensitivity of the uncertainty associated with the estimated field. This led to additional thoughts on the need to have a tool to adjust gridded rainfall data and forecasts for ingestion into the SARFFG. It was noted that such a tool would be particularly valuable for improving the development of warnings of potential flash flooding and riverine flooding, the latter being a potential product described below as a routing component.

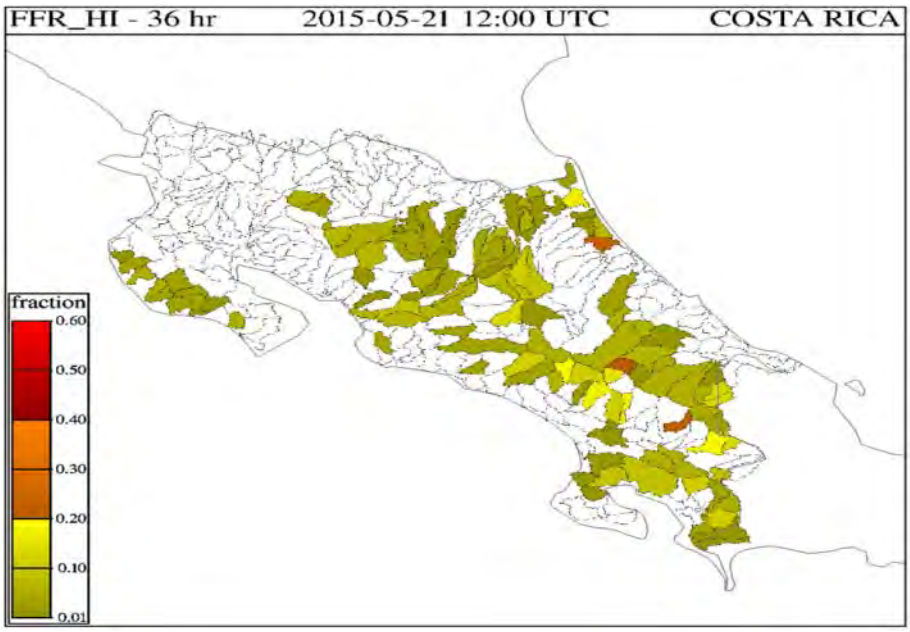

Figure 3: Example display of a potential flash flood risk product upon which alerts could be based.

The riverine routing component would provide the capability to estimate streamflow discharge at pre-specified locations along a specified river or rivers within the region, normally associated with riverine flooding where significant losses could occur. Products will provide simulations and forecasts. The modelling would be done through the FFG system and would be user activated for a specific river system of interest. It was mentioned that funding for the development of a prototype would be through a future work plan with HRC.

The SWFDP discussions include proposals to develop “Heads-up” products for forecasters and disaster managers. These products provide maps of potential severe weather hazards showing regions/municipalities with potential risk. Figure 4 provides an example of such a map showing areas of risk for flash flooding, high winds and high soil moisture, the latter being an important precursor for flash flooding.

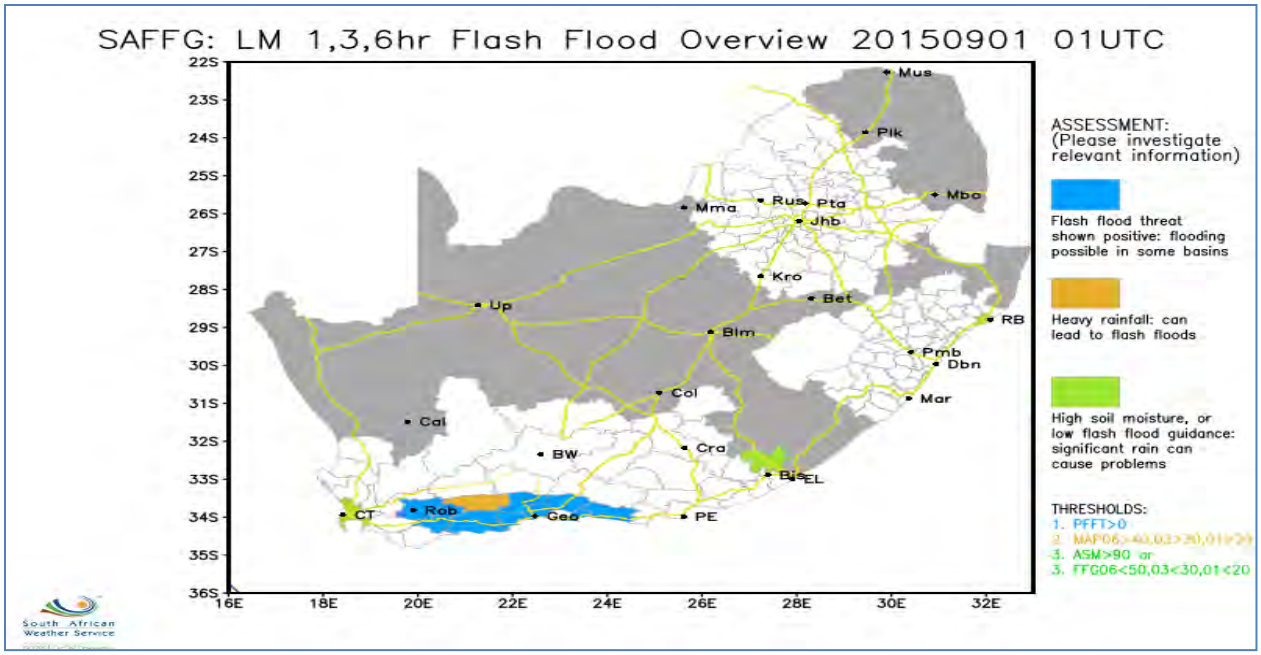

Figure 4: Example of a “heads-up” display map showing various selected potential severe weather hazards.

Participants also mentioned the advantages of including a new system capability termed an “FFGgram”, similar in concept to a “Meteogram”, that is a time series of rainfall, FFG, Flash Flood Threat (FFT), and soil moisture to aid the forecaster with understanding the flash flood risk. In addition,participants expressed the need for obtaining griddedQPF and adjusted gridded QPF data for ingestion into the SARFFG system at the regional level. Participants noted that the ingestion of the forecaster enhanced QPF into the SARFFG would be viewed as another forecast model option. HRC indicated that work is underway to include the capability for the FFG systems to incorporate a multi-model QPF function that allows the selection of a forecaster-specified model to use for the QPF in the system. In addition it was suggested that the SARFFG display the snow model output products as snow is possible in the higher regions of South Africa, Swaziland and Lesotho.

There was agreement from the participants of the need for the updated SARFFG forecaster interface, the flash flood risk product and the river routing component, as well as the potential complementary products described in the risk product paragraph above.

The product discussion also addressed the need for a portal developed specifically for disaster managers and managed by the NMHS. This portal would be password protected and provide a map showing the areas of risk for various parameters, much like the “Heads-up” product discussed above. The portal would also allow for a more detailed discussion of the risk including magnitude, impact and geographical location. There was unanimous agreement with the idea of developing the portal.

A schematic for a proposed disaster management portal is provided in Figure 5. The web page display provided in Figure 5 allows the disaster management expert to obtain a quick overview of on-going or potential hazards at the regional level via the top left box. Political and administrative boundaries would be overlaid and would allow the user to click on the area

having a hazard to see a detailed list of hydrometeorological hazards by event or parameter type (e.g., heavy rainfall, hail, high winds, flash flooding) on the right of the diagram. The user also has the ability to have this map view tailored to the individual country, with its appropriate political or administrative boundaries illustrated (e.g., provinces or states). Selecting the specific event or parameter for which warnings have been issued results in the text warning message to appear in the bottom left box within the figure.

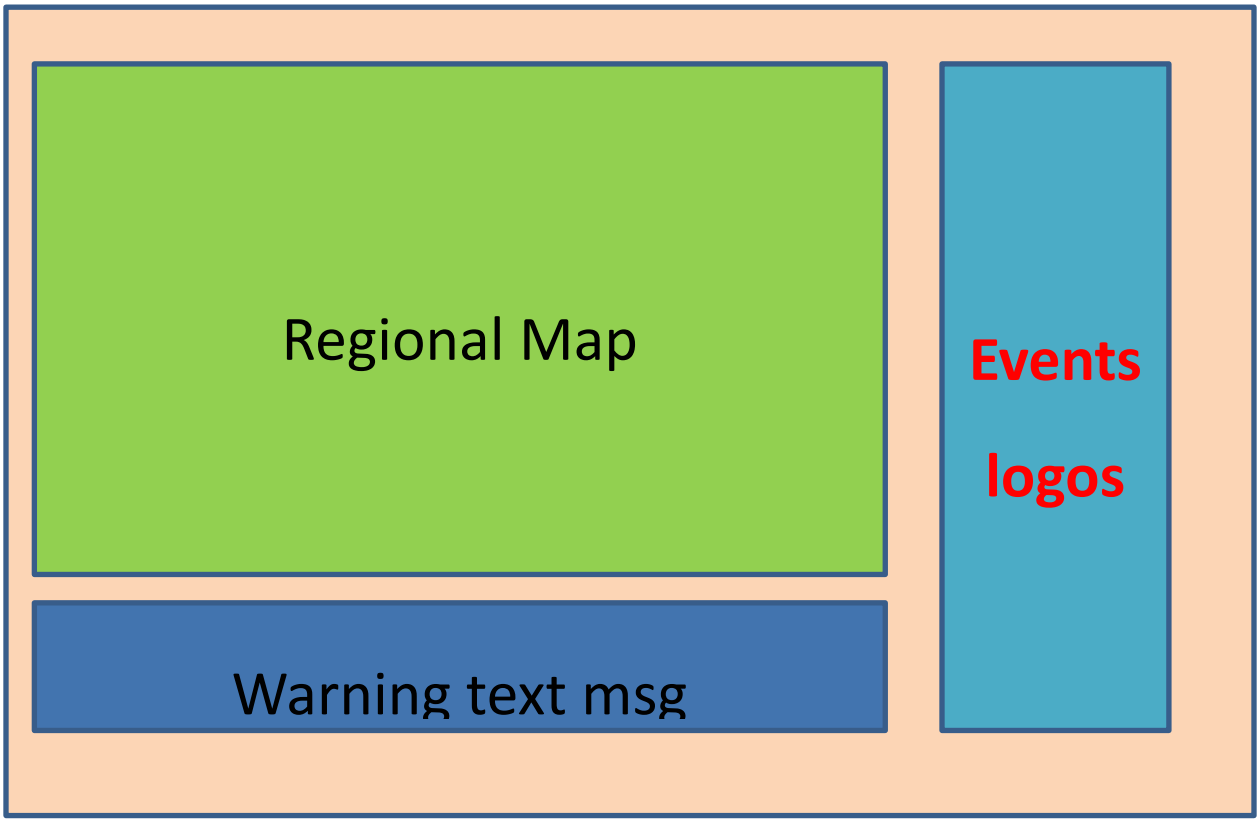

Figure 5: An example web page allowing disaster managers to access information on forecasts and warning of hydrometeorological hazards.

5. Overview of Implementation Plan (Roadmap)

Robert Jubach(HRC) provided a presentation on the typical material covered within a country-specific implementation plan (master roadmap or framework). The purpose of the presentation was to outline the requirements of the roadmap and to provide the participating countries with a generic template to assist countries in preparing its own document. The objective was for each participating country NMHS to develop a roadmap (as a planning tool) designed to meet the project goal of improving the accuracy, lead time, communication and dissemination of severe weather and flash flood warnings to communities. The roadmap is to address the elements of the end-to-end early warning system (as discussed in a previous section of this report). The document was started during the workshop and is expected to be completed upon the return of the participants to their home countries.

A draft template was provided participants for application to their country situations, and it is

shown below. Note they were provided the option to modify the templateto better address their situation in achieving the project goal. This template included a series of actionable steps.

Implementation Plan (Roadmap) Template
Elements of the template include:

- Early Warning Systems as a component of disaster risk management policies, with legislation and planning at national-to-local levels.
    - Need to have the mandates, procedures, and protocols in place for early warnings.
- Technical and operational capacities for observing, detecting, monitoring, forecasting and warnings.
    - Need to identify gaps in NMHS capacities.
- Warning and other product development and applications.
    - Need to identify mechanisms to ensure appropriate products for stakeholders.
- Communication and dissemination mechanisms from national-to-local levels.
    - Need to identify gaps in communication – infrastructure improvement, mandates, protocols.
- Support Early Warning System Operations
    - CONOPS

After the template was introduced and discussed, the participating experts from NMHSs broke into groups to begin the development of country documents. To do this,participants discussed the current status of early warning systems/forecasting operations in their countries and compiled lists of their gaps and weaknesses, the solutions to which could then be addressed in the roadmap. The following is a composite list of these gaps and weaknesses with indications of possible solutions as presented by the participants of the NMHSs.

NMHS Gaps and Weaknesses
The challenges faced by NMHS include:

- Shortage of personnel in the NMS and NHS for fulltime operations (24/7);
- Lack of skilled forecasters to generate the warnings;
- No alternative flash flood related data to support and complement SARFFG warnings;
- Inadequate meteorological and hydrological monitoring instrumentation;
- Sparse observing network (too few stations) to adequately cover the most vulnerable areas;
- Lack of localized forecasting models (high-resolution numerical weather prediction and hydrological forecast models);

- Limited skill in forecasting and in developing and disseminating warning messages;
- Lack of coordination between NMS and NHS (for countries where they are separate agencies); and
- Poor station network set-up and coordination, where, for example, NMS gauges do not directly feed data into the NHS system, and vice versa, which causes lack of information for informing actions.

Potential solutions to these gaps and weaknesses include:

- Provide additional/continued capacity building in both the NMSs and NHSs;
- Implement stakeholder workshops to share ideas, information, define needs and responsibilities, define capacities, and outline roles and responsibilities;
- Implement an integrated station network design so that NMS can directly feed data to the NHS, and vice versa;
- Establish better warning mechanisms by taking advantage of various regional initiatives; and
- Develop joint standard operations system for NMS and NHS (e.g. Operational Decision Support System that takes into consideration both parties' strengths and weaknesses) to facilitate, for example, sharing of data collected to international standards.

6. Individual Country Presentations on Current Warning Systems

The participants were from nine NMHSs (Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland,Zambia, and Zimbabwe). Experts from each country presented an overview of current early warning capabilities and capacities, including a description of hydrometeorological hazards, early warning products, administrative structure, system descriptions, operational activities, identified list of stakeholders, resources needed for the system operations, training needs, outreach, gaps and challenges. Individual country summaries are given below, while country presentations are summarized in tabular format in **Annex IV**.

Botswana

The expert from Botswana, MsAlice O. Oabile, provided an overview of the current products and services including numerical weather prediction models, daily and five-day forecasts, MSG satellite images, precipitation, remote sensing products such as NDVI (Normalized Difference Vegetation Index), Drought Risk Map, Soil Moisture Index Estimates and Active Fire, agro-meteorological bulletins, and aviation services. She further stated that the following warning products are produced and disseminated: Heat Waves, Cold Waves, Flood Warnings, Fog, and Strong Winds. She said that these warning products are disseminated to the users, including farmers, the general public, thewater sector, power utilities, construction, health and National Disaster Management Office (NDMO) usinge-mail, telephone, radio, television and facebook. She identified major challenges and gaps as being: gaps in in-situ observational networks; the inability of the current NWP models to resolve localized features (e.g. squall lines);an inability

for warnings to reach users in the most remote areas; lack of timeliness in issuing warnings such that they can be received after the hazard has already occurred.

Lesotho

The expert from Lesotho, Mr Charles Tseole, gave an overview of the products and services provided by the Lesotho Meteorological Department (LMD). These included products and services such as public forecasts, warnings of extreme weather events, aviation forecasts and services, seasonal forecasts and updates, weekly briefs, ten-day agro-meteorological bulletins (October-April) and emergency Water Release bulletins (October – December depending on the onset of good rains and need for water release). Then he stated that severe weather warnings are issued for strong winds, snowfall, cold spells, rainfall >50 mm, early frost and late frost, severe thunderstorms, hail, high temperature (>38ºC) and drought. He explained that weather forecast and warnings are produced based on the guidance products from RSMC Pretoria. <he indicated that the Disaster Management Authority (DMA) plays a major role in disseminating information to rural communities as they have put in place mechanisms that ensure the warnings reach users and communities ahead of time. He stated that the weaknesses and gaps are: 1) a formal National Early Warning System (NEWS), although one is currently being established and implemented at the time of this event; 2) rough terrain hampers proper dissemination of warnings as communication gets cut especially with inclement weather; and 3) most models don't pick up strong winds and deep CBs (Deep convection).

Malawi

The expert from Malawi, Mr Charles Vanya, explained that short-range weather forecasts (24-hours to 3days), medium-range weather forecasts (7-days, 10 days or decadal), long-range forecasts (a monthly or more) and seasonal weather outlooks are routinely produced. He further explained that SWFDP and SARFFG products are used in the preparation and issuance of the early warnings. He stated that flash floods, strong winds, thunderstorms, lightening and tropical cyclones are the major hydrometeorological hazards for which early warnings are issued. He continued by stating that warnings are disseminated through radio and television, internet, newspapers, telephones (mobile and wireless), SMS, and bulletins and newsletters. Finally, he said that the current main challenges and gaps include: inadequate staff to man operations 24/7; lack of experience to integrate information into useful messages (needs for further training); inadequate technological equipment and systems; lack of collaboration among stakeholders to meet the needs of the public; lack of proper guidelines for meteorological, hydrological and climate-related services; lack of proper early warning systems (real time) covering all sub-basins (main problem); lack of locally community-based systems managed locally; bureaucracies in operations; and inadequate observational networks.

Mozambique

The expert from Mozambique, MrIsacFilimon, explained that short-range weather forecasts, medium-range weather forecasts, long-range forecasts and seasonal weather outlooksw are produced routinely. He stated that SWFDP and SARFFG products are used to issue warnings which are disseminated to maritime authorities, water authorities, disasters management authorities, media, government using e-mail, fax, radio, phone, SMS, TV and Newspaper. He stated the main challenges and gaps included: that lack of availability of gridded rainfall data and forecasts; specific flash flood forecast tools to help produce warnings; and capacity building.

Namibia

The expert from Namibia, MrKaanguNguasananongombe, explained the flood forecasting system components including TRMM, MODIS, ESA satellite data and products and JRC GDACS, and then he cited the available hydrometeorological observations stations and the high

importance placed upon them. He stated that warning products are disseminated to local communities, EMA, Office of Prime Ministry (OPM), and the Farmer's Regional Council. He said that the main challenges and gaps include: coordination among stakeholders; gaps in the data collection netowrks; calibration of systems; inadequate staff; vandalism; poor maintenance of the stations; need for proper calibration and surveying of the gauging instruments;and a lack of involvement of community members in hydrological investigations and monitoring.

South Africa

The South Africanexpert, Ms Christina Thaele, explained the current forecast and warning products which are classified into three categories: watches and warnings; special weather advisory; and special collaborative warnings. She stated that watches and warning products are issued for strong winds, heavy rain, flashfloods, localized urban flooding, disruptive snowfalls, severe thunderstorms, high seas, special weather advisory products for widespread adverse cyclonic conditions, extremely hot conditions, high discomfort values, heat wave, snowfalls, frost,fog and reduced visibility, and special collaborative warnings on fire, tsunami, storm surges, and estuary flooding. She stated that warning products are disseminated to Disaster Management Agencies, Councillors and Tribal Chiefs, Emergency Services, Police, Traffic and Response Agencies, Media Members, and insurance companies using SMS, e-mail, Common Alert Protocol (CAP) messages, and the SAWS website. She concluded her presentation by listing the main challenges and gaps. These included: adequate radar coverage; the SARFFG system; lack of upper air ascents; messages to the end users not always being reachable.

Swaziland

The expert from Swaziland, MrBuhleSimelane, provided an overview of the current products and services of the Swaziland Meteorological Service saying that they can be grouped into three categories: These are: 1) public weather services forecast and warning products fromnowcasting, short to medium range daily weather forecasts, severe weather forecasts, thunderstorms and lightning, wind storms, heavy rain, dense fog, Fire Danger Index (FDI), and heat and cold waves, and fires; 2) aviation services products including METAR, TAF and aerodrome warnings; and 3) advisory services products such as long range and seasonal forecasts, bulletins, dry spells, drought, climate, and El Nino. He explained that these products are distributed to public, aviation industry, media, government organizations (Forest, Railway, Hotels, Water Services, Electricity, Sugar Cane, Tertiary Institutions, and construction), and research communities using fax, e-mail, SMS, NMS webpage, and phone.He indicated that the main challenges and gaps included: model resolution over a small area like Swaziland not allowing resolving local effectsand heterogeneous terrain; lack of standardized forecast verification process in the region; lack of standardized early warning system in the region;and heavy reliance on independent media for disseminating warnings and alerts (e.g., print media).

Zambia

The expert from Zambia, Mr Felix Imbwae, provided an overview of the current products and services produced by Zambia Meteorological Department such as: seasonal weather forecasts; crop weather bulletins; daily weather forecasts; climate database services; seven-day weather forecasts; climate variability; and climate change and adaptation awareness; aviation services; and severe weather early warnings on droughts, floods, flash floods, tropical cyclones, thunderstorms, and strong winds. He showed examples of flash flood events and regions that are affected by flash floods. He said the warning products are distributed to aviation authorities, agriculture sector, water resource management authorities, education and research entities, health authorities, buildings and civil engineering authorities, Disaster Management Agency, Insurance, commerce and industry, tourism, and sport authorities via radio, TV, newspapers, e-mail, ZMD website, the community-based dissemination programme, and the RANET project.

Finally, he said that main challenges and gaps included: inadequate station network density; obsolete meteorological and telecommunication equipment; missing data in the climate datasets; limited skilled manpower; inadequate facilities for effective data processing and dissemination; lack of feedback from users of forecast and warnings; insufficient information on user needs; inadequate interaction with users of forecasts and warning; and limitations in climate information reaching vulnerable communities.

Zimbabwe
The expert from Zimbabwe, MrKudakwashe Joel Kayirasora, provided an overview of roles in flood monitoring including river monitoring network, dam operations, flood monitoring reports and hazard maps. Then, he specified the challenges and gaps as being: data scarcity; inadequate automatic weather observing systems; no riverine flood forecasting model; lack of public awareness and education; shortfalls in enforcement of the civil protection legislation; inadequate and centralisation of rescue equipment; lack of and financial resources; structural organisational gaps in the management of disasters; bureaucracy, poor communication networks with the vulnerable communities; lack of inundation maps; no formal agreements on exchange of flood related information among riparian states; lack of appropriate strategy for flood plain management.

7. Development of Concept of Operations Plans (CONOPS)

The second event focused on the User/CONOPS Workshop. Disaster Management Agencies were invited to participate in the first day of the second event. Disaster Management Agency experts provided presentations and their views on needs for meteorological and hydrological forecast products, warnings and services.Their needs are listed in **Annex V**.

Messrs James Purpura (WeatherExtreme Ltd.), Curt Barrett (USAID/OFDA), and Eugene Poolman(SAWS)made presentations on the Concept of Operations (CONOPS) development.

The main points emphasized on the development of a concept of operations plan are given below.

Development of a CONOPS

- What is a CONOPS?
    - A CONOPS is defined for this workshop as a document describing the likely operation of a future or existing system in the terminology of its users, providing important information for the acquisition and/or development of that system.
- Why do we need a CONOPS?
    - Forecast and Warning systems are complex and dynamic systems, CONOPS will help ensure subsystems are integrated into an effective system. Essentially SWDFP and SARFFG are merged as part of a “System of Systems”, which the concept shown in Figure 6.

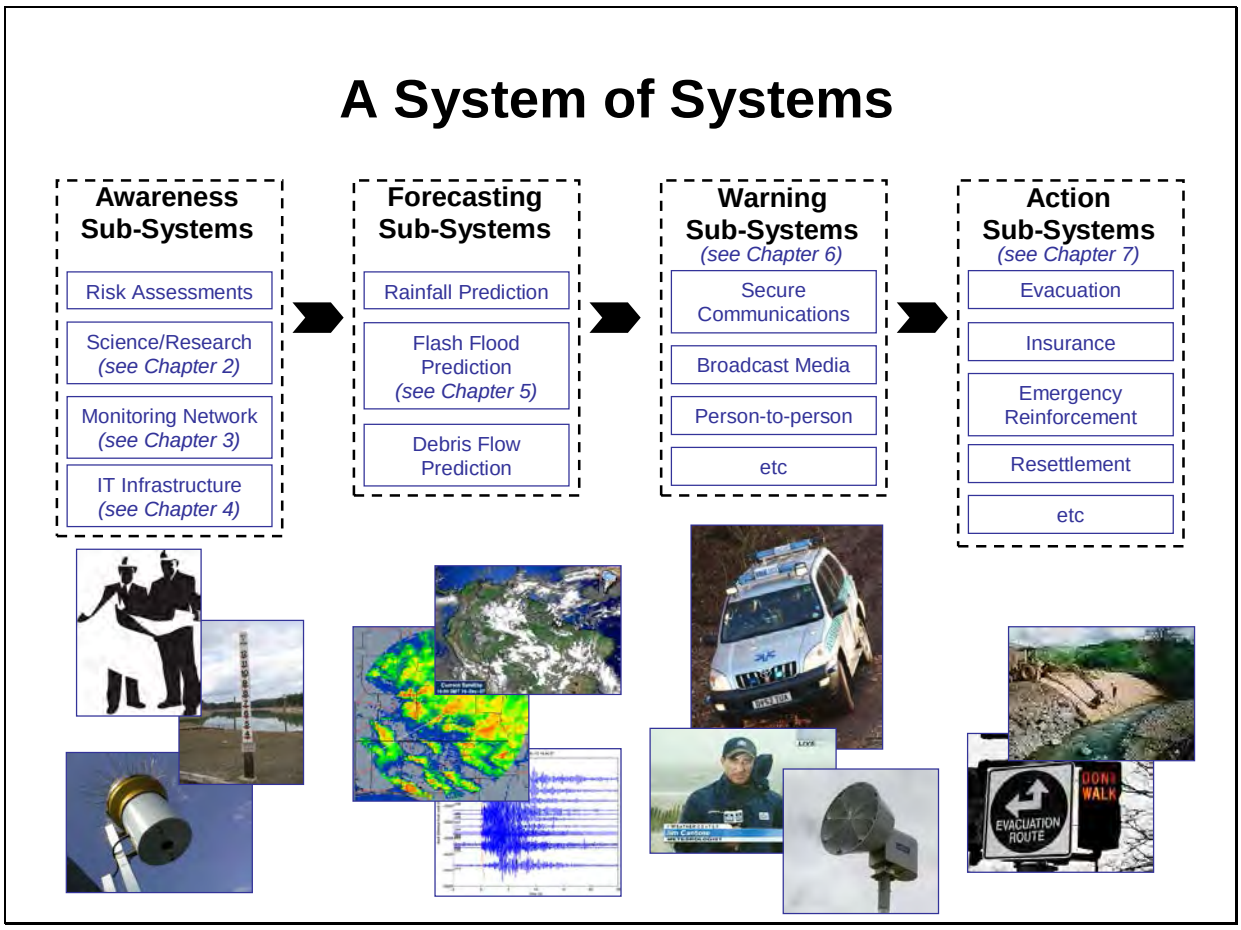

Figure 6: Diagram illustrating the system-of-systems concept applied to an end-to-end early warning system.

- CONOPS is viewed as the first part of the Systems Engineering Life Cycle Process as shown in Figure 7.

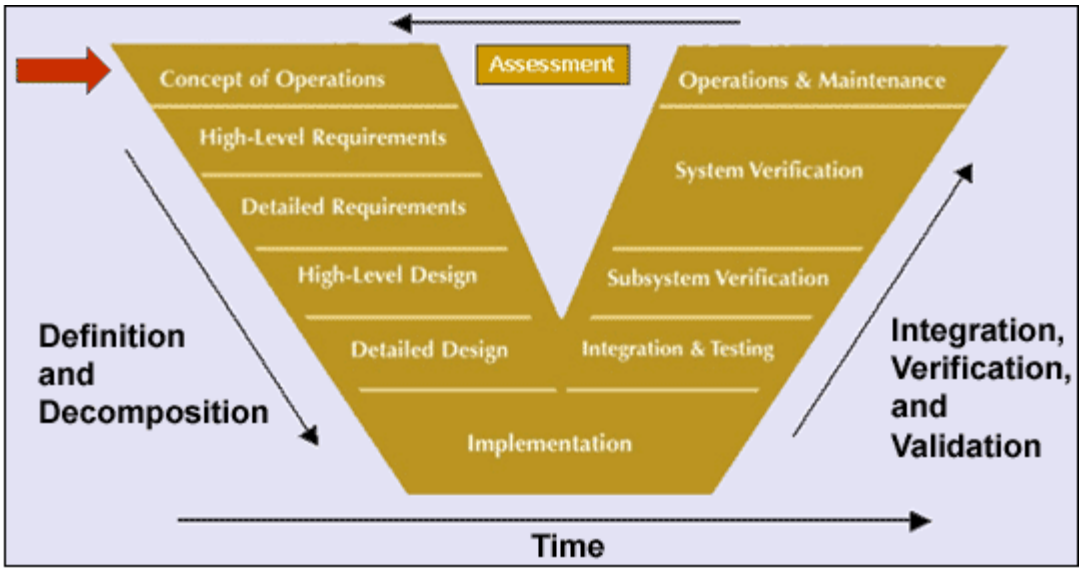

Figure 7: Diagram illustrating the life cycle process and the CONOPS within it.

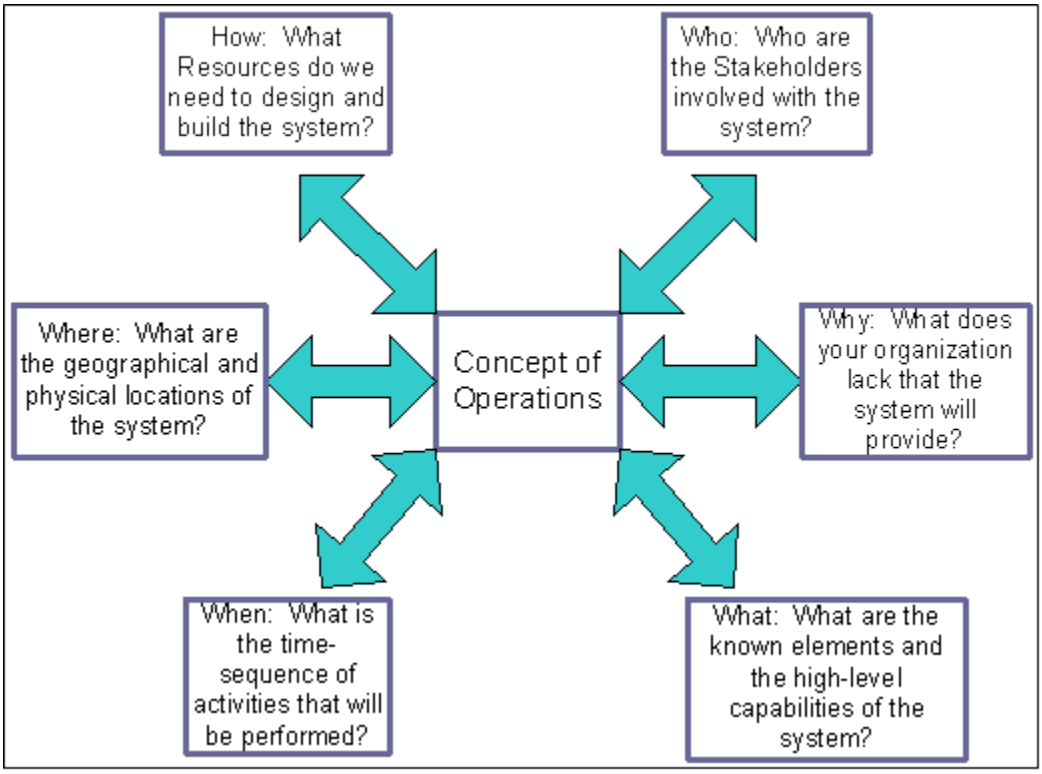

Figure 8: Diagram illustrating the essential questions to be addressed by a CONOPS.

Emphasis was placed on the elements of a CONOPS, which included:

- Five questions that must be answered in each CONOPS, as shown in Figure 8.

    - Scope.
    - Knowledge References.
    - Operational Description.
    - System Overview.
    - Operational and Support Environments.
    - Operational Scenarios.
- Some mistakes to avoid included:
    - Expecting system vendors, contractors, or external partners to develop CONOPS for your agency.
    - Postponing CONOPS development until equipment is ordered or delivered.
    - Allowing inadequate resources for CONOPS development.
    - CONOPS development by unqualified staff.
    - Cut and paste vs. development of your own plan.
    - Neglecting to update your CONOPS.
- Participants received a Requirements Checklist handout to assure their completed CONOPS document contained all needed information.

Example of an implemented CONOPS
Mr Eugene Poolman (SAWS) made a presentation of the Flash Flood Guidance System to a portion of the Republic of South Africa (RSAFFG) CONOPS, as an example of what a completed CONOPS of this type might look like. Highlights of the SAWS CONOPS included:

- Introduction
- Background
- RSAFFG Operation and Information Flow
    - RSAFFG is implemented in 5 areas in the Republic of South Africa, based on radar coverage in flash flood prone areas near Gauteng, Durban, Cape Town, Port Elizabeth, and on the Cape SouthCoast. Figure 9 shows the area of application of the RAFFFG system.

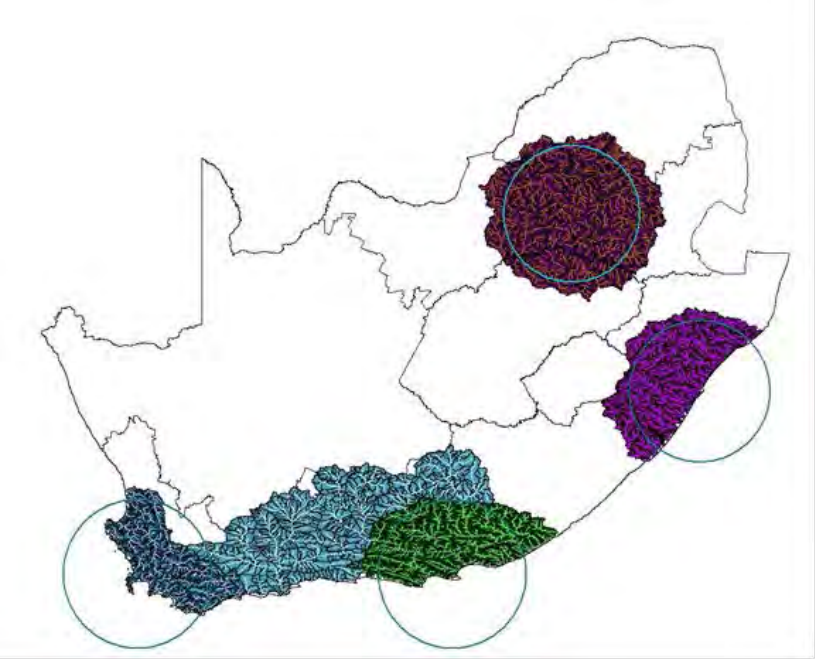

Figure 9: Map showing the area of application of the Republic of South Africa Flash Flood Guidance System with circles depicting areas with radar coverage.

Emphasis was also placed on understanding the flow of data, information and products within the end-to-end warning system for hydrometeorological hazards. Figure 10 depicts the flows of data, information and products within the SAWS early warning system including the communication of the warnings with disaster management agencies, media and communities.

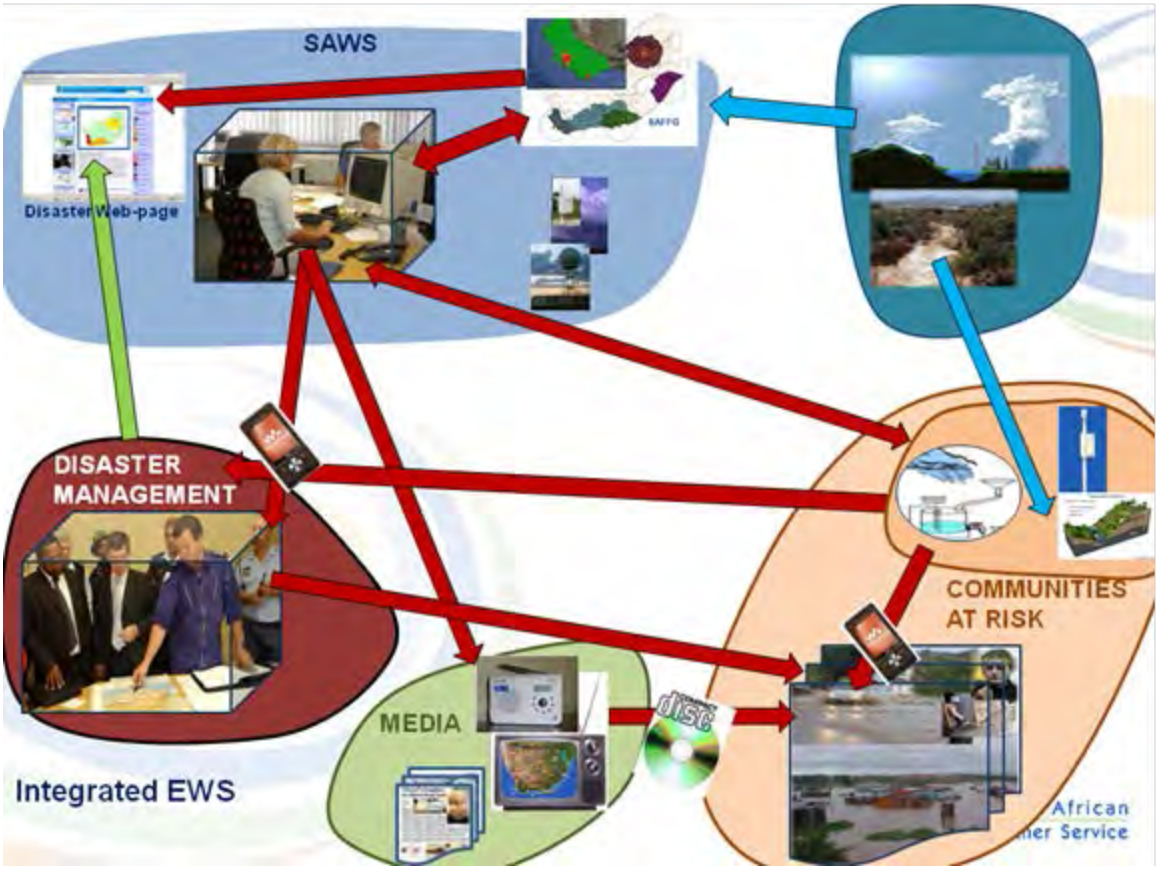

Figure 10: Schematic illustrating the flow of data, information and products within an en-to-end early warning system as developed by the South African Weather Service.

Figure 11 provides additional details on the development of forecasts and the provision of early warnings to users, while Figure 12 shows the institutional responsibilities of operational and support components in the development of early warnings. Activities include: routine operations,staff training, non-routine operations, and outreach.

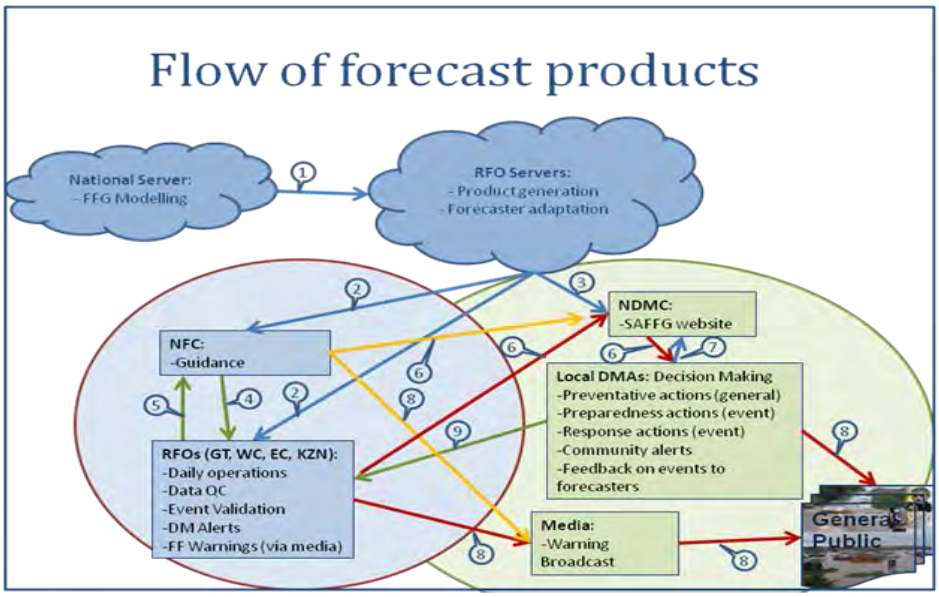

Figure 11: Schematic depicting the development of forecast products and their flow to users.

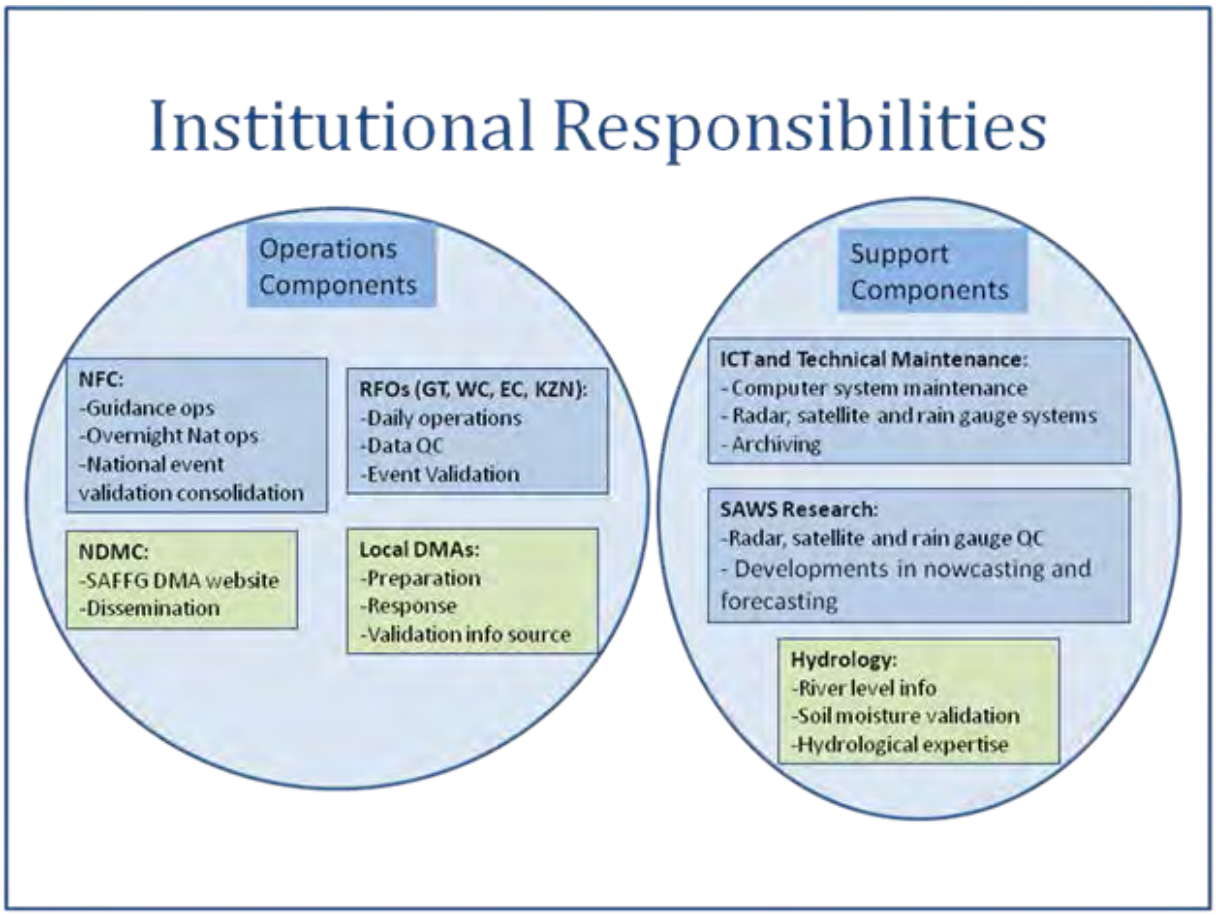

Figure 12: Institutional responsibilities of operational and support components.

Some important reasons for developing a CONOPS were provided as being:

- To help ensure that when a country receives that they will be compatible with other existing systems within the NMHS.
- To avoid fragmented operations that become a detriment to operations.
- To aid in the development of future systems. Donors will be given more precise information on the characteristics and capabilities of systems needed to be a part of an integrated system.

CONOPS Template
A CONOPS template was distributed, based on the experience from the development of the RSAFFG system.

The template outline is given below.

1. Introduction
    - Purpose of document. Overview of proposed system.
2. Background
    - Overview of the SWFDP-FFG system linked system, its operations, and components
3. Institutional Responsibilities
    - Information Flow
4. Staff Operational Responsibilities and Specialty Areas (various offices if appropriate)
5. Hours of Operation
    - Routine and extended
    - Contacts (normal and off hours)
6. Responsibilities of Support Structures
    - IT and technical components
    - Research in Meteorology
    - Research in Hydrology
7. National Forecast Centre (NFC)
    - Operational roles and responsibilities
    - System management/maintenance roles and responsibilities
8. Regional Forecast Offices (RFOs), if appropriate

- Operational roles and responsibilities
- System management/maintenance roles and responsibilities

9. Routine Operations

- FFG/SWDFP product overview
- Preliminary evaluations
    - Meteorological evaluations
        - Previous, current, forecast
        - Satellite evaluation
        - Radar evaluation (where available)
    - Hydrological evaluations
        - Soil moisture
        - Stream conditions
        - Reservoir levels
    - Quantitative precipitation forecasts
- SWFDP and SARFFG product evaluations and applications
- Information dissemination
    - Routine bulletins
    - Watches/warnings/alerts
    - Be sure to consider
        - National communication system
        - Television
        - Radio
        - Satellite
        - Mobile communications/SMS
        - Social Media
            - Facebook
            - Twitter
    - Reporting requirements

- Information flow back to forecaster
    - Trained observer?
    - Media?
    - Weather Spotter?
    - Public Reports?

10. Staff training needs

11. Outreach

- Coordination with users (other agencies, Emergency Managers, media, public) on existing products and services, providing training on new products

12. System Validation

13. Non-routine operations – Operations during unusual events.

CONOPS Development Exercise
Mr Curt Barrett (USAID/OFDA) led a discussion of the development process followed by an exercise where the participants were divided into 3 groups. Since SAWS has been through the process of a CONOPS, a SAWS representative participated in each of the three groups to help facilitate the process.

Further discussion focused on how to approach the development of a CONOPS helped the participants focus their attention on particular areas. The participants were given time to begin the development of a CONOPS. After reconvening, each group gave presentations on the status of their work for the day. Significant progress was made on the development of dra<ft CONOPS by completion by User/CONOPS Workshop.

8. Next Steps and Workshop Wrap-Up

Significant advances had been made by participants in understanding the concepts and the advantages of developing a Roadmap and Concept of Operations Plan for their NMHSs. Participants agreed that it would be beneficial for them to continue these efforts following the meeting and workshop and that it would be beneficial to involve others within their NMHS, as appropriate, to help ensure accuracy and completeness. Participants also requested that a letter be sent to their Permanents Representatives, copying the Hydrological Advisers, outlining the importance of the development of these documents and raising the importance of participants in having time to complete their efforts. Once the documents have been completed, participants are to send them to MrAyhanSayin (Asayin@wmo.int), copying MsMireilleHerin (Mherin@wmo.int) where they will be reviewed. It was indicated that an additional event would be likely held in the first quarter of 2016 to further the process of finalizing the documents.

The participants thanked the hosts of the meeting and commented on the lovely facilities and efforts undertaken by the hosts that contributed to the positive atmosphere of the meeting. Participants also thanked WMO, USAID/OFDA, HRC, RSMC Pretoria and their fellow participants for their efforts in making the meeting a success and in sharing their views.

Participants expressed that they were looking forward to continuing the work to be undertaken in advancing the development of a Roadmap and CONOPS for their NMHSs.

It was agreed that the report of the meeting and workshop would be circulated for comment prior to its finalization likely to be completed within one month of the meeting. The workshop closed at 16:30 Friday 30 October 2015.

Annex I

Delivery of Warnings of Hydrometeorological Hazards Southern African Region

PROJECT BRIEF

October 2015

Project Overview

The USAID Office of U.S. Foreign Disaster Assistance (OFDA) along with the World Meteorological Organization (WMO), RSMC (Regional Specialized Meteorological Centre) Pretoria , the U.S. National Oceanic and Atmospheric Administration / National Weather Service (NOAA/NWS) and the Hydrologic Research Center (HRC) have agreed to develop a project to link and enhance the Southern Africa – Severe Weather Forecast Demonstration Project (SWFDP) and Southern African Region Flash Flood Guidance (SARFFG) systems with an objective to provide improved service delivery of forecasts, warnings and information to the Disaster Risk Reduction (DRR) agencies/organizations at the regional, national and local levels in Southern Africa in order to reduce loss of life and property. See Appendix A for an overview of the SWFDP and SARFFG systems.

This project will: 1) integrate/link hardware, software and data in both the SARFFG and SWFDP systems; 2) improve forecast operations at RSMC Pretoria and the nine Southern African countries that have access to both systems; 3) build capacity of the hydrological and meteorological operations of each national center and RSMC Pretoria; and 4) improve service delivery to the National and Regional Disaster Management agencies and DRR users through improved warnings(e.g., lead time, message content and impact information), dissemination and enhancement of severe weather disaster awareness, preparedness and response. For this project to deliver improved services, it will integrate/link and enhance two fully operational systems, build capacity through training and develop and implement a severe weather/flash flood concept of operations (CONOPS) for each country for warning services to connect to disaster response operations and users so that lives can be saved.

Both the SWFDP and the SARFFG are regional-based systems that have been designed to provide forecasters at the National Meteorological and Hydrological Services (NMHSs) the necessary data and information to provide timely and effective warnings of severe hydrometeorological events, including conditions for rainfall that could lead to flash floods, thus protecting life and property in their countries. Because they are regional-based systems, they provide these data and information efficiently and cost-effectively. Both systems encompass end-to-end early warning system (EWS) concepts by including the elements of 1) observing, detecting and developing hazard forecasts and warnings; 2) assessing the potential risks and integrating risk information in the warning messages; and, 3) distributing, rapidly and reliably, understandable warnings to authorities, risk managers and the population at risk as well as many other users, such as the agricultural sector. Linking the two systems both programmatically and technically enhance their capabilities to address the fourth element of an end-to-end EWS – emergency preparedness and response to warnings at all relevant levels (national to local) to minimize the potential impacts of extreme hydrometeorological events.

Linkages between the systems will lead to improvements in the capabilities of both initiatives and create closer collaborations between NMHSs, leading to improved service delivery. A particular emphasis will be placed on “reaching the last mile”, making sure warnings developed from both systems reach the affected population and users timely and accurately and are in a format that can be easily understood and acted upon to achieve maximum value in resulting disaster response actions. Improved linkage between NMHS warning products and services to national and community disaster response activities is the principal goal for integrating these two successful forecast and warning systems.

Project Definition

The overall goal of the project is to improve accuracy, lead time, communication and dissemination of severe weather and flash flood warnings to communities. To accomplish this goal, the project will consist of the following elements:

- Linking the SARFFG and SWFDP systems that are now operating separately at RSMC Pretoria with products available at nine NMHSs in Southern Africa.
- Improving Forecast Operations – In both systems there are daily operational and maintenance functions conducted that need to be better synthesized. In addition, the dissemination of products from each system needs to be better organized so meteorological forecasters can transmit alerts and warnings faster and directly to user agencies allowing them to take response actions more quickly.
- Capacity Building – There is a significant need to train forecasters at RSMC Pretoria, and the forecasters at the nine NMHSs on operations and applications of the two systems. In addition training is essential for the user community which primarily consists of national, regional and local disaster management agencies as well as active NGOs.
- Awareness, Preparedness and Response —For the Disaster Risk Reduction (DRR) sector in each country, the degree of outreach and readiness needs to be assessed. This includes the available materials and brochures, as well as the legal frameworks in effect to assure effective use of improved warnings and forecasts. An essential aspect of this project is having the DRR community clearly define the information and products they need to maximize response and minimize loss of life and property.

All activities will be undertaken in three phases over a three year period.

Phase 1 Activities

Since Phase 1 activities are more clearly defined than those for Phases 2 and 3 at this time, the focus on this project brief will be on Phase 1. Activities for Phase 1 include those noted in Table 1.

TABLE 1. PHASE 1 ACTIVITIES AND CURRENT STATUS

ACTIVITY	STATUS (As of October 2015)
2015 regional cross-training workshop on SARFFG and SWFDP systems operations – THIS IS PROVIDED FOR INFORMATION ONLY, THIS IS NOT A PROJECT PHASE I ACTIVITY AS IT HAS A SEPARATE FUNDING SOURCE	Planned for November 2015 in Pretoria (RSMC Pretoria)
Regional technical meeting on SARFFG-SWFDP integration/system linkages Develop Roadmap for regional and country end-to-end warning development applying linked SARFFG and SWFDP systems Regional user workshop to define warning requirements	All activities planned for a workshop 26-30 October 2015 in Pretoria (WMO, USAID/OFDA, HRC, RSMC Pretoria)

TABLE 1. PHASE 1 ACTIVITIES AND CURRENT STATUS

ACTIVITY	STATUS (As of October 2015)
Regional and country linked SARFFG-SWFDP system application CONOPS workshop (in conjunction with user workshop) Develop Draft CONOPS for nine SARFFG/SWFDP countries	
SARFFG operations training at HRC for nine SARFFG countries	Scheduled for 8 September – 2 October 2015 (WMO and HRC)
SARFFG system interface upgrade	Preliminary design started (HRC and RSMC Pretoria)
Begin other SARFFG and SWFDP systems development	Preliminary designs started (HRC and RSMC Pretoria)
Begin satellite rainfall QPE validation	Started (HRC and RSMC Pretoria)
Develop and disseminate project information through various media	Started (WMO)

There are two principle goals for Phase 1. These are to: 1) determine the requirements of regional and country forecasters to produce products and data needed by users as well as requirements needed by the national-to-local DRR community for improving severe weather and flash flood warnings; and 2) begin SARFFG and SWFDP systems linkage development work.

To accomplish these Phase 1 goals, the following will be determined: a) data and information needed by both forecasters and users; b) definition of new and improved user products and services that will assist disaster managers in establishing appropriate response actions to the forecasted hazard; c) dissemination and communication links needed to reach users; d) the required NMHS forecaster resources and skills; and e) the outreach processes and practices of the Disaster Management community and stakeholders. Essentially, the end-to-end forecast-warning-response system needs to be evaluated regionally and individually for each of the nine SARFFG/SWFDP countries. Gaps need to be identified and overcome to ensure effective and maximum response to severe weather and flash flood threats to communities. In other words, each of the components of the end-to-end system needs to be fully functional. This process will be accomplished through country NMHS and stakeholder discussions and products defined at the technical and user workshops to be held in October 2015 (as noted in Table 1).

Important activities in Phase 1 include the development of the Roadmap (or framework) and Concept of Operations (CONOPS) documents during the October 2015 workshop. Development of these documents will be a joint effort among WMO-OFDA-HRC-country participants.

In addition to developing a Regional Roadmap, each NMHS will construct a Roadmap specific to their country. These Roadmaps are a detailed plan to provide guidance towards meeting the overall project goal as defined earlier and applying the linked SWFDP and SARFFG systems. The Roadmap will outline project objectives, deliverables, work plans, timelines and organizational makeup. A Roadmap template will be provided and discussed during the October 2015 workshop. An example output from a Roadmap work plan for the South Asia Flash Flood Guidance (SAsia-FFG) system is as shown in Figures 1 and 2. In

the example, the roadmap steps and subsequent activities and the partner responsibilities required to meet the goal are noted.

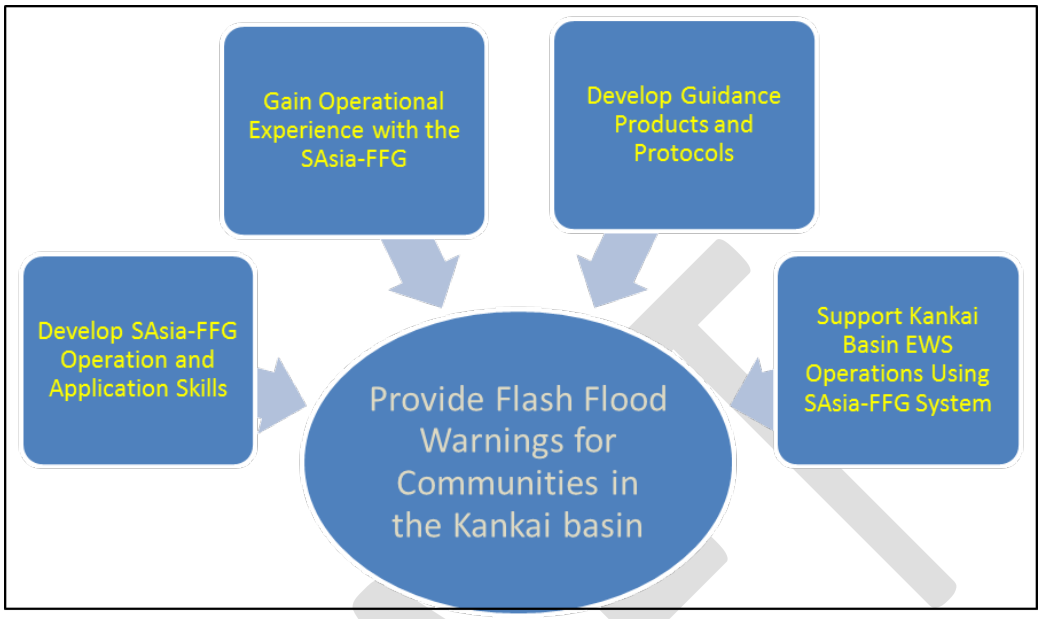

Figure 1. Example Roadmap Steps from SAsia-FFG for Meeting the Goal of Providing Flash Flood Warnings for Communities

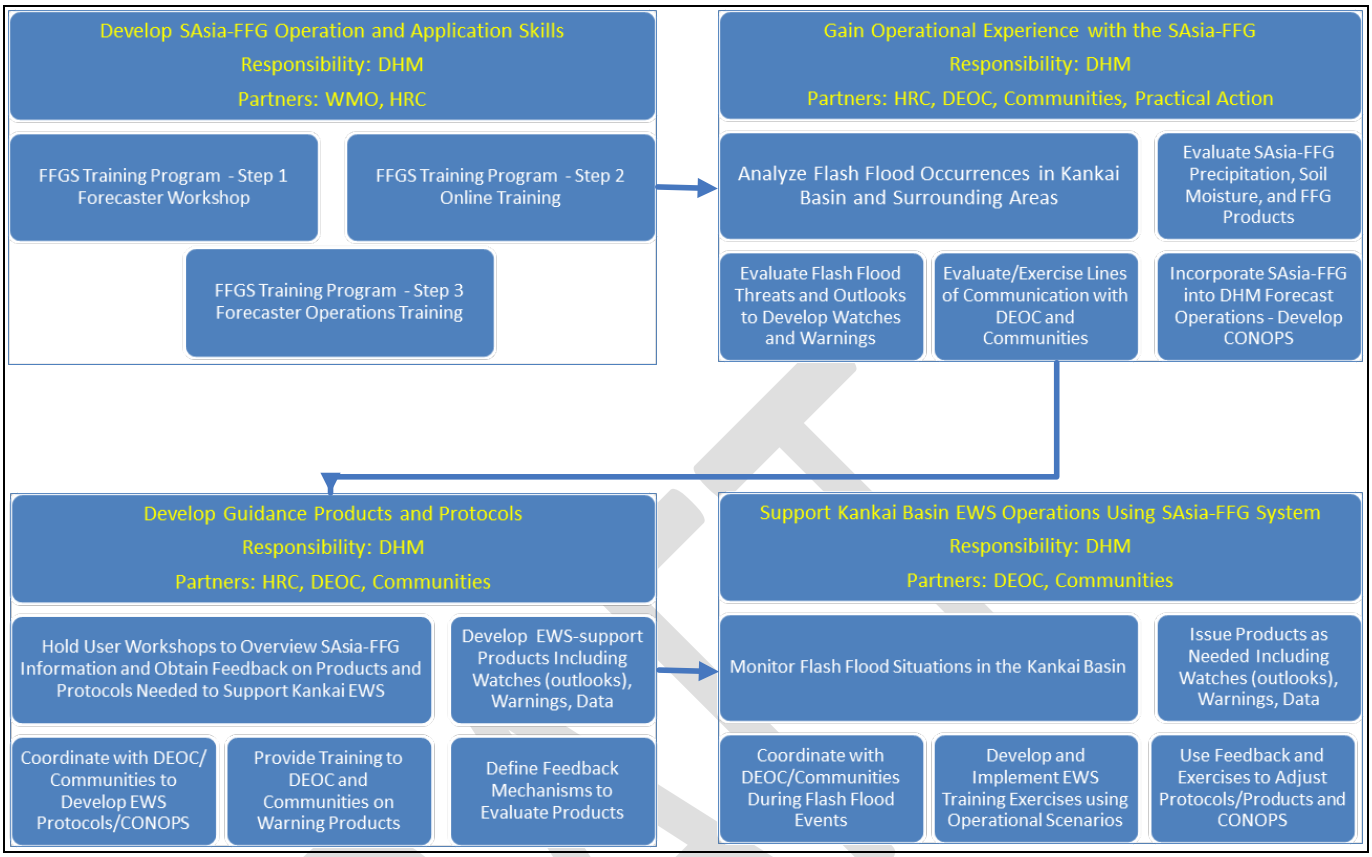

Figure 1. Example Simple Roadmap for SAsia-FFG Showing Activities

A CONOPS document for the integrated and linked systems in each country and for the region will also be prepared during the October 2015 workshop. A CONOPS document is critical and provides a clear outline of the flow of activities necessary to produce routine and non-routine operations, data/information flow, responsibilities, and ongoing training for the linked systems. Included are linkages to all aspects of the end-to-end processes that comprise an EWS and ensure integration into current or future NMHS forecast operations. It provides the top-level technical specifications and functionality of the EWS, as well as its look and feel. A CONOPS template for the integrated systems will be provided and discussed at the workshop. Typical topics in a CONOPS document include:

- Systems descriptions
- Identification and responsibilities of all stakeholders, including NMHSs
- Purpose of the systems, what gaps do they fill, priorities to be addressed, goals and objectives
- Capacity of the systems to fill the gaps
- Time sequence of operational activities – routine operations, non-routine operations
- Physical location of the systems and access requirements
- Resources needed for system operations; identification of and responsibilities of system support structures (e.g., IT)

- Data and information flow, communications
- Training needs and requirements
- Outreach requirements

In preparation for the development of the CONOPS document for an EWS through the SWFDP-SARFFG integrated systems, it is necessary to first document current NMHS forecast operations. The type of information needed for the current operations is provided in Appendix B**. It is requested that the participants determine the information as outlined in Appendix B prior to the workshop.** Appendix C provides a preliminary structure for the SWFDP-SARFFG CONOPS document that will be developed during the workshop.

The development work integrating the systems will also begin during Phase 1. During this phase, an upgrade to the SARFFG forecaster user interface will be developed and implemented. This upgrade will allow viewing of SARFFG system products over a variety of user-defined layers (e.g., terrain, political boundaries, roads, etc.) as well as provide an interactive capability to allow scrolling, zooming and data interrogation (e.g., time series displays). Other system development work will begin during this phase, including:

- Capability for the SARFFG to ingest forecaster prepared products such as adjusted model-derived Quantitative Precipitation Forecasts (QPFs)
- A single forecaster user interface or dashboard that allows the regional or country forecaster to access a *Quick Map Hazard* product suite to visualize current hazards noted from SWFDP forecaster-developed products (e.g., high wind warnings) or from SARFFG output products (e.g., flash flood threats). Each NMHS office will have access to the same dashboard to compose forecast and warning products.
- An automated process that will provide location-specific guidance maps for ongoing or forecasted hazards. These maps show hazards over user-defined areas (such as districts, communities) with such forecasts possibly being disseminated to the many local users and disaster management agencies and stakeholders.
- Development of a flash flood risk capability for the SARFFG based on ensemble precipitation forecasts from SWFDP.

A schematic of potential new products and their organization are shown in Figure 3.

These and other potential new products will be discussed during the October 2015 workshop.

Other critical activities under Phase 1 include:

- Validation of the satellite rainfall estimates as provided by the SARFFG (NOAA Global Hydroestimator-based QPE). Once validated and corrected for bias as needed, these high resolution estimates can be used for model-based QPF verification efforts.

- SARFFG operational training of forecasters from the nine countries that are part of the SARFFG initiative. The training will provide background on the technical system components and operations to develop flash flood alerts and warnings.

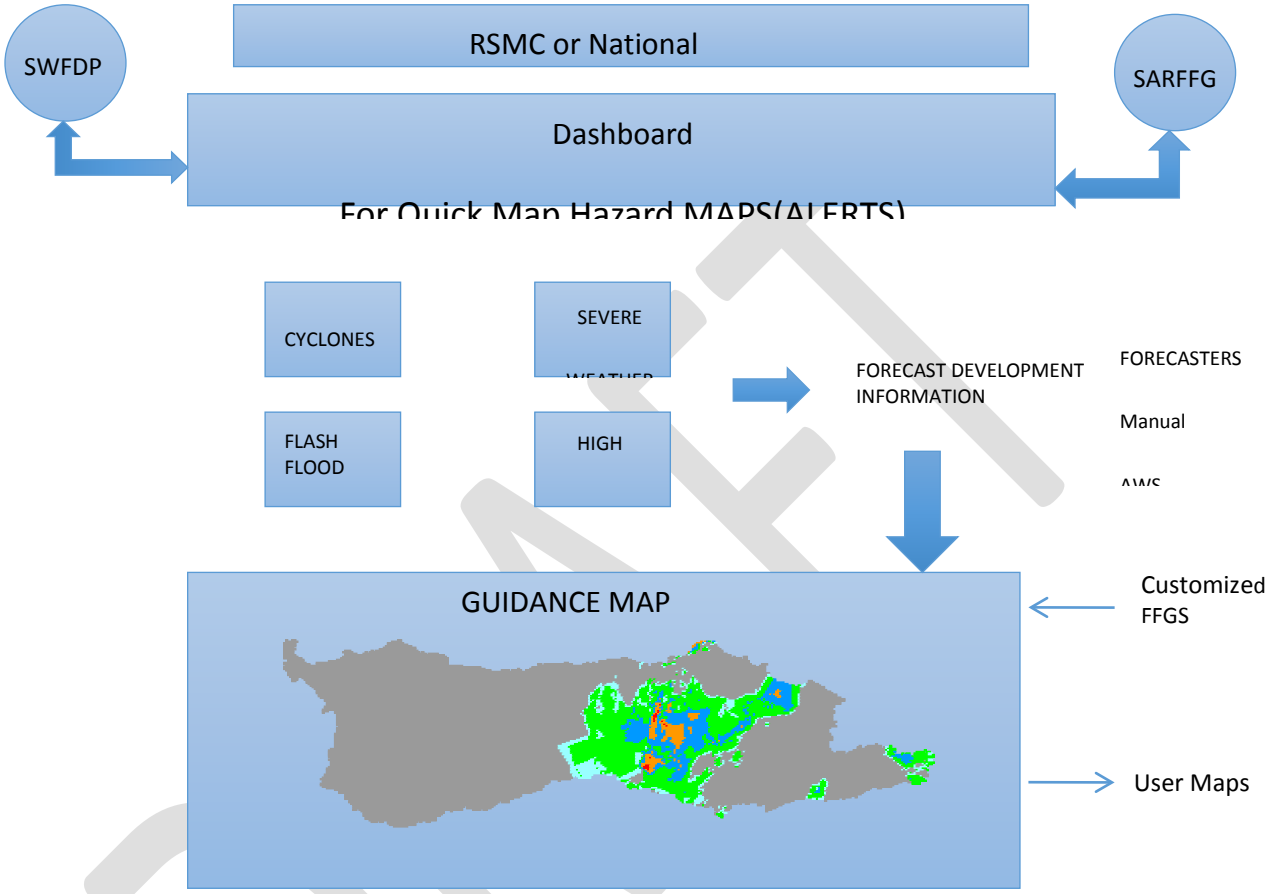

Figure 3. Potential New Products Schematic

Appendix A

Overview of the SWFDP and SARFFG Systems

Severe Weather Forecasting Demonstration Project (SWFDP)

The SWFDP has improved the lead-time and reliability for alerts about high-impact events such as heavy precipitation, strong winds, and damaging waves. It has strengthened NMHS interaction with disaster management and civil protection agencies, local communities and media. The SWFDP is making a major contribution to disaster risk reduction and is contributing to the Millennium Development Goals, in sustainable development, as well as climate change adaptation. More broadly, the project is benefitting society and its key socio-economic sectors both in safety of population and operations, including disaster risk reduction, and in economic performance, including agriculture, fisheries, aviation, water resource management and marine transportation, where meteorological prediction is crucial.

In essence the SWFDP is a process whereby scientists from global and regional centres work with severe weather forecasters at the national level to identify services that would assist the national disaster response and risk reduction efforts, and that can be implemented almost immediately by tailoring numerical weather prediction model outputs and other forecasting tools that exist in the most advanced centres, and making them routinely available at the national level. The majority of NMHSs are not able to develop or run the weather forecast models due to lack of capacity and resources. The SWFDP employs a 'Cascading Forecasting Process' whereby outputs from forecast systems that are available and free in advanced global centres are cascaded to NMHSs through a designated regional centre which provides interpretation and guidance on severe weather from the next few hours (nowcasting) to the next 5 days (short- to medium-range forecasting). This allows forecasters at the NMHSs to focus limited resources on considering the impact of this weather in their country and on service delivery and communicating the message to users in their countries to ensure timely and effective early warnings and protective responses. A SWFDP project includes building capacity of national meteorologists in the application of the cascaded information and in the development of services to meet the disaster management communities' needs. Opportunities are taken to involve disaster managers, and the news media in preparation of the user requirements.

Southern African Region Flash Flood Guidance (SARFFG) System

The SARFFG system was designed and developed for use by meteorological and hydrological forecasters in the Southern African region (specifically the countries of Botswana, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe; also included in the SARFFG domain are Lesotho and Swaziland). The primary purpose of the SARFFG is to provide operational forecasters and disaster management agencies with real-time informational guidance products pertaining to the threat of small-scale flash flooding throughout the region. The SARFFG provides the necessary products to support the development of warnings for flash floods from rainfall events through the use of satellite-based rainfall estimates and hydrological models.

The SARFFG outputs are made available to users to support their analysis of weather-related events that can initiate flash floods (e.g., heavy rainfall, rainfall on saturated soils) and then to make a rapid evaluation of the potential for a flash flood at a location. To assess the threat of a local flash flood, the SARFFG is designed to allow product adjustments based on the forecaster's experience with local conditions, incorporation of other information (e.g., Numerical Weather Prediction output) and any last minute local observations (e.g., non-traditional rain gauge data) or local observer reports. The system can be used in its real-time mode or in a forecast mode when outputs are used along with nowcasting and NWP precipitation forecasts. The system supports evaluations of the threat of flash flooding over hourly to six-hourly time scales.

Important technical elements of the SARFFG system are the development and use of a bias-corrected satellite precipitation estimated field and the use of land-surface hydrological modelling. The system then provides information on rainfall and hydrological response, the two important factors in determining the potential for a flash flood. The system is based on the concept of **Flash Flood Guidance** and **Flash Flood Threat.** Both indices provide the user with the information needed to evaluate the potential for a flash flood, including assessing the uncertainty associated with the data.

In February 2009, a Memorandum of Understanding (MOU) was signed among the World Meteorological Organization, the U.S. Agency for International Development/Office of U.S. Foreign Disaster Assistance, the U.S. National Oceanic and Atmospheric Administration/National Weather Service, and the Hydrologic Research Center to work together under a cooperative initiative to implement systems such as the SARFFG system worldwide.

Linkage of the SWFDP and the SARFFG Systems

In essence, these two activities have been implemented in the region of southern Africa in parallel and have similar concepts of operation and basic approaches. At the same time, they have distinct differences in relation to both the temporal and spatial nature of each extreme hydrometeorological event and on the emphasis of the hazards they address, SWFDP being meteorological and SARFFG being hydrological hazards, which requires different approaches, yet each separate system could benefit from technical linkages.

Appendix B

NMHS Forecast Operations Documentation

Administrative Structure

- Describe your NMHS administrative structure, staff size
    - Your NMHS Headquarters
        - Location
        - Number of staff
        - Number of Meteorologists/Hydrologists/IT personnel?
    - Field Offices (if appropriate)
        - Location(s)
        - Number of staff
        - Number of Meteorologist/Hydrologists/IT personnel?
        - Does this office have operational responsibility, administrative responsibility, or both?

System Descriptions

- Describe the current capability your hydrometeorological systems have in place. For example
    - Radar
    - Satellite
    - Lightning
    - Surface Observation Networks
        - Real-time
        - Other
    - Rain Gauge
    - Flood Gauges
    - Volunteers/ Weather Spotters (if appropriate)
        - Are your Weather Spotters trained? (briefly describe training and reporting process)
        - Do you receive reports from untrained observers or public reports? (briefly describe how these are received)
        - Do you receive reports through social media, e.g., Facebook, Twitter, etc.?
    - Do you generate forecast model or other guidance generated in your own country or do you use guidance from an International Centre?
        - If you use your own guidance, please elaborate on what you generate and how you use it.
        - If you use externally generated guidance:
            - What do you use, where do you get it from
            - Does it meet your needs?
            - If not, what improvements could you use in guidance?

- Dissemination systems descriptions
    - Forecast and warning dissemination systems
    - Communication systems between operational offices
    - Describe the communication systems you use to warn Emergency Management Services authorities, media, and the public.
    - Do you have warning system in place using mobile phones?
    - Do you have warning systems in place using social media?
    - To the extent possible, provide a description and diagram of how data flow is managed

Purpose of the Systems Described Above

- For the systems identified above, please answer the following questions:
    - What is the purpose of each system?
    - What area of observation do they cover?
    - What are the priorities of the systems?
        - Rank the system according to how important they are in terms of ongoing and emergency repair/maintenance support.

Gap Filling Capabilities

- Are there gaps in your observational networks?
    - If so please describe
        - Location(s)
        - Type of gap (what information is missing?)
- Are there any efforts underway or planned to fill observational gaps?
    - If so please describe

Operational Activities

- Please describe the routine products issued by your NMHS
    - How frequently are they issued?
    - What are the stakeholders of each product?
- Please describe the non-routine (as needed) products issued by your NHMS
    - What are the stakeholders of each product?

Identification of Stakeholders

- Who are the stakeholders for your products? (We will define a “stakeholder” as a person with an interest or concern in your activities.)
- What are the needs of the various stakeholders for warning services?
    - Number of Meteorologist/Hydrologists/ IT personnel involved in developing/disseminating warnings?

Location of Your Physical Systems (Radar, Computers, Weather Sensors, etc)

- Please provide a map of these systems (if readily available).
-

Resources needed for system operations

- What resources are needed to continue system operations with your present level of service?
- What resources are needed to support system operations in levels of service with planned improvements/upgrades over the next five years?

Training Needs/Requirements

- What are your anticipated training needs/requirements for the new systems being implemented?

Outreach/Education Requirements

- What types of outreach and education efforts are planned to help support the implementation of this system? Include the following:
    - Internal: NMHS staff
    - External:
        - Media
        - Emergency Services
        - Public

Appendix C

Integrated SWFDP-SARFFG System

Early Warning System Concept of Operations Document Structure (Preliminary)

10. Introduction
    - Purpose of document

11. Background
    - Overview of the SWFDP-SARFFG linked system, its operations, and components
12. Institutional Responsibilities
    - Information Flow

13. Staff Operational Responsibilities and Specialty Areas (Various offices if appropriate)

14. Hours of Operation
    - Routine and extended
    - Contacts (normal and off hours)

15. Continuous Product/data system viability

16. National Forecast Centre
    - Operational roles and responsibilities
    - System management/maintenance roles and responsibilities

17. Regional Forecast Offices (if appropriate)
    - Operational roles and responsibilities
    - System management/maintenance roles and responsibilities

18. Routine Operations
    - FFG product overview
    - Preliminary evaluations
        - Meteorological evaluations
            - Previous, current, forecast
            - Radar operations
        - Hydrological evaluations
            - Stream conditions
            - Reservoir levels
        - Quantitative precipitation forecasts
    - SWFDP and SARFFG product evaluations and applications
    - Information dissemination

        - Routine bulletins
        - Watches/warnings/alerts
    - Reporting requirements

14. Staff training

15. Outreach
    - Coordination with users (other agencies, media, public) on existing products and services, providing training on new products

16. System Validation

17. Non-real-time operations
    - System maintenance/review

18. Non-routine operations – Operations during unusual events

Annex II

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Annex III

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

South Africa Severe Weather Forecast Demonstration Project (SWFDP) and Southern Africa Region Flash Flood Guidance (SARFFG)
Regional Technical Meeting and User/CONOPS Workshop

Reaching the Last Kilometer

26 – 30 October 2015

Hosted by the South African Weather Service
Pretoria, South Africa

Integration Program Goal: To improve accuracy, lead time, communication and dissemination of early warnings of extreme hydrometeorological hazards with appropriate lead times to reduce loss of lives and livelihoods and to protect property and the environment in the Southern Africa region.

Workshop Purposes: 1) Introduce the Integration Project on bridging and enhancing the two systems capabilities, by bringing experts together to review system architecture and to further develop and agree upon the system integration implementation plan (also referred to as the Roadmap) for both the national and regional levels. 2) Establish DRR user community input on warning requirements and value of decision support tools and products that are needed to promote effective responses. 3) Begin the process of developing Concept of Operations Plans (CONOPS) for the integrated programmes linking the systems within each country and at the regional level. .

Workshop Outcomes:

1. An increased understanding amongst participants of the SWFDP-SA and SARFFG projects and the effort to integrate system capabilities.
2. Input by the DRR user community for the types of warning products and services required to improve emergency responses.
3. An increased understanding amongst participants of the capabilities and capacities of NMHSs and their users' needs and requirements for early warnings for extreme hydrometeorological hazards.
4. Feedback on potential new and enhanced features of the SARFFG Forecaster User Interface including user-defined layers (e.g., terrain, political boundaries, roads, building locations, etc.).
5. Initial development of a roadmap (framework) to integrate the SWFDP and SARFFG projects to improve interfaces/products/information from both projects to strengthen the capacities of NMHS to better support their users for early warnings of hydrometeorological hazards.

6. Initial development of a draft Concept of Operations Plan document for each country and regional centre to outline the application of the integrated and linked SWFDP-SA and SARFFG systems into their forecast and warning operations.

Participants:

1. Hydrologists and meteorologists from the nine SARFFG country NMHSs
2. Emergency management representatives from the nine SARFFG countries
3. SWFDP and SARFFG Regional Centers representatives
4. USAID/Office of U.S. Foreign Disaster Assistance representative
5. World Meteorological Organization representatives for SWFDP and SARFFG
6. Hydrologic Research Center representatives
7. Representatives of other donors - TBD

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

Monday October 26, 2015
Day 1-Integrated Program Roadmap Session

Participants: South African Weather Service (SAWS/RSMC), World Meteorological Organization (WMO), USAID/Office of U.S. Foreign Disaster Assistance (OFDA), Hydrologic Research Center (HRC), Representatives from the National Meteorological and Hydrologic Services (NMHS) from Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

0830 – 0900	**Registration**	**All Participants**
0900 – 0930	**Welcome and Introductions**	**All Participants**
0930 – 1030	**Introduction and overview of the Meeting and expected outcomes for the two events** **Introduction to technical meeting sessions—Oct 26-27** **Explain project background** **Roadmap development** **Meeting purposes and goals**	**Paul Pilon (WMO)** **Paul Pilon (WMO)** **Curt Barrett (OFDA)**
1030 – 1100	**Tea Break**	
1100 – 1130	**Overview of SWFDP Project, User Interface/Products**	**AbdoulyeHarou (WMO)** **Eugene Poolman (SAWS)**
1130 – 1200	**Overview of SARFFG, its User Interface and Products**	**Eugene Poolman (SAWS)** **Robert Jubach (HRC)**
1200 – 1230	**Achieving the End-to-End Forecast and Warning System-Focusing on the last Kilometer**	**Curt Barrett (OFDA)**
1230 – 1330	**Lunch**	
1330 – 1500	**NMHS presentations (10 minutes each)[2]**	**NMHSs**
1500 – 1530	**Tea Break**	
1530 – 1600	**SWFDP and SARFFG interfaces and new product considerations for the Integrated System**	**Eugene Poolman (SAWS)** **Robert Jubach (HRC)**
1600 – 1640	**Facilitated discussion on emerging products and services**	**All participants**
1640	**Adjourn**	

[2]NMHS participants are asked to present up to five power point slides and limit presentations to 10 minutes:
Slides 1/2 Current products and services? What are severe weather and flash flood forecast & warning products?
Slides 3/4- How are forecasts and warnings produced?
How are products disseminated to users? How do products reach users?
Who are users? What do they do with information?
What are weaknesses and gaps in the forecast and warning process?
Slide 5- What new products would improve forecast services? Provide specific examples and say why?

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

Tuesday October 27, 2015
Day 2-Integrated Program Roadmap Session(continued)

Participants: South African Weather Service (SAWS/RSMC), World Meteorological Organization (WMO), USAID/Office of U.S. Foreign Disaster Assistance (OFDA), Hydrologic Research Center (HRC), Representatives from the National Meteorological and Hydrologic Services (NMHS) from Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

0900 – 0930	**Review of Day 1 –accomplishments and actions**	**Paul Pilon (WMO)**
0930 – 1030	**Discussion on emerging products and functional capabilities**	**All participants** **Facilitators –** **Eugene Poolman (SAWS)** **Robert Jubach (HRC)**
1030 – 1100	**Tea Break**	
1100 – 1200	**Overview of implementation plan (master roadmap or framework) and how it will be accomplished**	**Robert Jubach (HRC)** **Eugene Poolman (SAWS)** **AbdoulyeHarou (WMO)**
1200 – 1300	**Lunch**	
1300 – 1600	**Development of individual country roadmaps**	**NMHSs** **Facilitator –** **Curt Barrett (OFDA)**
1600 – 1640	**Summary and the way forward**	**All participants** **Facilitator –** **Paul Pilon (WMO)**
1640	**Adjourn**	

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

Wednesday October 28, 2015
Day 3-CONOPS[3] Session

Participants: South African Weather Service (SAWS/RSMC), World Meteorological Organization (WMO), USAID/Office of U.S. Foreign Disaster Assistance (OFDA), Hydrologic Research Center (HRC), Representatives from the National Meteorological and Hydrologic Services (NMHS) and Disaster Management Agencies (DMAs) from Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

0900 – 0910	**Welcome and Introductions**	**All participants**
0910 – 0925	**Introduction and overview of the Workshop and expected outcomes for the two workshops**	**Paul Pilon (WMO)**
0925 – 0935	**Focusing on the last kilometer—How the End–to-End System reaches the community at risk**	**Curt Barrett (OFDA)**
0935 – 0950	**Background and overview of the integrated SWFDP and SARFFG system**	**Paul Pilon (WMO)** **Curt Barrett (OFDA)**
0950 – 1030	**Review of products and services discussion (Technical Meeting)**	**Eugene Poolman (SAWS)**
1030 – 1100	**Tea Break**	
1100 – 1230	**Presentations by Disaster Management Agencies - 10 minutes each[4]**	**DMAs**
1230 – 1330	**Lunch**	
1330 – 1500	**Country breakout group sessions to review draft roadmaps and evaluate needs and requirements**	**NMHSs and DMAs**
1500 – 1530	**Tea Break**	
1530 – 1630	**Country presentations (5 minutes per country) summarizing breakout group discussions**	**NMHSs and DMAs**
1630 – 1640	**Summary of workshop activities and the way forward for Thursday**	**Paul Pilon (WMO)**
1640	**Adjourn**	

[3] Concept of Operations (CONOPS)

[4] What kind of warnings or notifications do you receive of impending weather and flash flood hazards? What improvements are needed for both severe weather and flash floods?What type of specific products, text, and graphics would you like to see?

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

Thursday October 29, 2015
Day 4-CONOPS Session (continued)

Participants: South African Weather Service (SAWS/RSMC), World Meteorological Organization (WMO), USAID/Office of U.S. Foreign Disaster Assistance (OFDA), Hydrologic Research Center (HRC), Representatives from the National Meteorological and Hydrologic Services (NMHS) from Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

0900 – 0915	**Review of Technical Meeting (two days on roadmap) and Day-1 of CONOPS Workshop**	**Paul Pilon (WMO)**
0915 – 0945	**Overview of CONOPS development process for extreme hydrometeorological hazards – incorporating the linked SWFDP and SARFFG system; building the End-to-End Early Warning System**	**Curt Barrett (OFDA)** **Jim Purpura (WeatherExtreme, Ltd)**
0945 – 1000	**Illustration of CONOPS example**	**Jim Purpura (WeatherExtreme, Ltd)**
1000 – 1030	**Presentation of CONOPS template**	**Jim Purpura (WeatherExtreme, Ltd)**
1030 – 1100	**Tea Break**	
1100 – 1200	**Country breakout group sessions to draft CONOPS**	**NMHSs** **Facilitators** **Curt Barrett (OFDA)** **Jim Purpura (WeatherExtreme, Ltd)**
1200 – 1300	**Lunch**	
1300 – 1630	**Country breakout group sessions to draft CONOPS (continued)**	**NMHSs** **Facilitators** **Curt Barrett (OFDA)** **Jim Purpura (WeatherExtreme, Ltd)**

Agenda
Regional Technical Meeting and User/CONOPS Workshop
Pretoria, South Africa

Friday October 30, 2015
Day 5-CONOPS Session (continued)

Participants: South African Weather Service (SAWS/RSMC), World Meteorological Organization (WMO), USAID/Office of U.S. Foreign Disaster Assistance (OFDA), Hydrologic Research Center (HRC), Representatives from the National Meteorological and Hydrologic Services (NMHS) from Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe.

0900 – 1030	**Brief presentation by NMHSs on status of CONOPS development**	**NMHSs**
1030 – 1100	**Tea Break**	
1100 – 1200	**NMHSs break into groups and work on drafting CONOPS (continued)**	**NMHSs** **Facilitators** **Curt Barrett (OFDA)** **Jim Purpura (WeatherExtreme, Ltd)**
1200 – 1300	**Lunch**	
1300 – 1430	**NMHSs break into groups and work on drafting CONOPS (continued)**	**NMHSs** **Facilitators** **Curt Barrett (OFDA)** **Jim Purpura (WeatherExtreme, Ltd)**
1430 – 1530	**Discussions on path forward (commonalities and differences)**	**All participants**
1530 – 1600	**Next Steps and Workshop wrap-up**	**Paul Pilon (WMO)** **Curt Barrett (OFDA)**
1600	**Adjourn**	

Annex IV

Summary of Early Warning Features for NMHSs in Southern African Region

	Botswana	**Lesotho**	**Malawi**	**Mozambique**	**Namibia**	**South Africa**	**Swaziland**	**Zambia**	**Zimbabwe**
Early Warnings issued on the following Hydrometeorological Hazard Types									
Flash Floods/Floods	X	x	x		x	x	x	x	x
Heavy Precipitation		x	x			x	x		x
Drought		x	x				x	x	x
Strong winds	X	x				x	x	x	x
Thunderstorms		x				x	x	x	
Lightening Adv.			x						x
Tropical Storms Adv.						x	x	x	
Extreme Temperature		x				x	x		x
Heat Waves	X					x	x		
Cold waves	X						x		
Dry Spell			x				x		

Forest Fire						x	x		x
Fog	X						x		
Rough Sea						x			
Urban EWS						x			
Snow		x				x			
Comfort values						x	x		
Frost		x				x	x		
Visibility						x			
Tsunami						x			
Storm Surge						x			
Estuary flooding						x			
Hail		x					x		x
FDI							x		
Provision of Weather Forecasts									
Short Range	X	x	X			x	x	x	
Medium Range	X	x	X			x	x	x	
Long Range	X		X			x	x	x	

Routinely Access the following Models									
SWFDP			X			x	x	x	
FFGS			X			x	x	x	
COSMO			X			x			
WRF			X						
RSMC			X	x		x	x	x	
ECMWF							x	x	x
NCEP							x	x	x
UK Met. Office							x	x	x
UM						x	x		
NOAA							x		x
Routinely Access Satellite Images									
EUMETSAT		x	x	x		x	x	x	x
Early Warnings are Disseminated to the Following Users									

EMA	X		x	x		X	x	x	x
Water Resources Managers	X			x				x	
Maritime Auth.				x					
Media				x	x	X	x		x
Government Agencies				x			x		
Farmers	X				x		x		x
Office of the Prime Minister					x		x		
Regional Council					x				
Aviation							x	x	
Education And Research							x	x	
Health	X						x	x	
Building and Civil Eng.	X						x	x	
Companies and Industry							x	x	
Tourism and Sport							x	x	
Public	X					X	x		x
Power	X						x		

Councillors and Tribal chiefs						x			x
Emergency Services						x			
Police						x			
Insurance Companies						x	x	x	
NGO									x
Ways of Disseminating Early Warnings									
Radio	X		x	x			x	x	x
TV	X		x	x			x	x	x
Internet			x	x		x	x	x	
Newspapers			x	x			x	x	
Telephone	X		x	x			x		x
SMS			x	x		x	x		x
Bulletin and Newsletters			x	x			x		
email	X			x		x	x	x	
Fax				x			x		
Social Media	X						x		x

CAP						x			
Challenges and Gaps									
Lack of staff/skilled forecasters to produce early warnings			x		x		x	x	
Lack of adequate observation network	X		x		x		x	x	x
Training Needs					x		x		x
No 7/24 operations			x				x		
Inadequate technology			x				x		
Lack of cooperation among government orgs.			x		x		x		
Lack of guidelines for Met. andHy. Services			x				x		
Lack of public education and awareness			x				x		
Vandalism					x		x		
Poor maintenance of the					x		x		

equipments									
Lack of proper EW Systems		x	x				x		
Bureaucracy			x				x		
Lack of Quantitative products such as QPF			x	x			x		
Lack of area specific products			x				x		
Lack of investment inHy. and Met.					x		x		
Inadequate climate datasets/ climate research							x	x	
Lack of data processing and Dissemination								x	
Lack of Feedback from users								x	
Lack of information on user needs								x	
NWP failure	X						x		
Warning NO reaching to people in remote regions/ and public	X	x				x	x		

Lack of Radar coverage						x	x		
Weaknesses of SARFFG						x	x		
Lack of Radiosonde stations						x	x		
Lack of impact based warnings		x					x		
Lack of Nowcasting system		x							
NO Standardized regional EWS							x		
Lack of verification system							x		
Lack of High Resolution model							x		

Annex V

Disaster Management Needs for Meteorological and Hydrological Forecast Products,Warnings and Services

Need to emphasize the impacts in warnings – e.g., heavy rainfall warning – will flooding occur? Who will be affected and where?

Need to undertake risk assessments by hazard and by season

Impact-based early warning systems should show magnitude of damages and extent of hazard (e.g., flood hazard and risk mapping)

Would like multi-hazard maps of area of responsibility

Closer collaboration and more data sharing

Challenge to disseminate warnings to end users

Government doesn't support early warning systems

New Disaster Risk Reduction policies needed

Products and services from NMHSs are too complicated and hard to understand, need to simplify them.

Scale down forecasts to districts and sectors

Use SMS to text cell phones (CAP)

Put local language in forecasts

Have products and services on web portal, make better use of internet

Need to train media

Take advantage of indigenous knowledge and science for early warnings

Improve and make available satellite-based weather products

Terminology needs to be defined, for example, what does "moderate danger" mean? Not just colors on a map but impact on the ground. Need more specific information.

Increased development and use of visual products

Apply social sciences to forecasting to improve comprehension

Use crowd sourcing

Probabilistic climate outlooks expressed as normal or above normal, not enough detail provided to be of value

Need long term climate forecast information (1-3 months)

Geo RSS feeds for spatial data