FIRST STEERING COMMITTEE MEETING (SCM 1)

CENTRAL ASIA REGION FLASH FLOOD GUIDANCE (CARFFG) SYSTEM

Astana, Kazakhstan

14–16 September 2015

[W1]

FINAL REPORT OF THE FIRST STEERING COMMITE MEETING

September 2015

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Steering Committee Meeting 1 (SCM 1) of

The Central Asia Region Flash Flood Guidance (CARFFG) Project

Astana, Kazakhstan, 14-16 September 2015

1. Executive Summary

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

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

The Central Asia Region Flash Flood Guidance (CARFFG) System planning workshop was held in Ankara, Turkey on 5-7 May 2015. Five Central Asian countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, were represented in the workshop. Participants expressed their interests to participate in CARFFGS, indicating that flash floods cause considerable human losses and property damages. At this meeting, the National Meteorological and Hydrological Service (NMHS) of Kazakhstan(Kazhydromet) graciously offered to host the Regional Centre of the CARFFG system, which was accepted by all participating countries. Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan have thus far sent Letters of Commitment (LoC) to WMO to participate in the project.

Based on the CARFFG system implementation plan adapted at the planning workshop in Ankara, Turkey, the first CARFFG system Steering Committee Meeting (SCM 1) was organized by WMO in Astana, Kazakhstan. The SCM consists of the focal points of each participating NMHSs or their alternates and representatives of the partner organizations, namely HRC, USAID/OFDA, US NWS and WMO. Additional experts/representatives may also be invited by the Steering Committee (SC) meeting as needed on an ad-hoc basis, and observers may also be invited to participate. Therefore, WMO on behalf of the SC sent invitations to attend the meeting to: the NMHS of Uzbekistan (Uzhydromet), the Severe Weather Forecast Demonstration Project – Central Asia (SWFDP-CA) COSMO Limited Area Model (LAM) scientists from the NMHS of the Russian Federation (Roshydromet) working on the World Bank Central Asia Hydrological Modernization Project (CAHMP), and a representative of the CAHMP.

The purposes of this meeting were: to review the theoretical basis of the Flash Flood Guidance System; to explore in detail, through presentations and discussions, the project products, their development methodology, and the interpretation and validation approaches to provide feedback for their further development; to allow a better understanding of the needs of high resolution modelling, including its domains, to support the CARFFGS application; and to seek the possibility of using the QPF and other products of COSMO Limited Area Model in CARFFGS.

The SCM 1 also represents Step 1 of the flash flood hydrometeorological training programme.

2. Opening of the Session

In opening the first Steering Committee Meeting, the representatives of Kazakhstan, WMO and USAID/OFDA highlighted the importance of improving the timely delivery of flash flood information and guidance to the populations at risk and in the importance of fostering stronger partnerships among countries in the region to strengthen national capabilities to forecast and warn populations at risk from flash flooding and other hydrometeorological hazards. Although the core aspects of the project focus on the implementation of technology and scientific approaches undertaken mainly by the countries NMHSs, it was highlighted that the guiding indicator for the ultimate success of the project is effective outreach to people and reducing their risk of being affected by flash floods in a disastrous way.

In his opening remarks, Mr Uzakbay KARABALIN, first vice minister of Energy of Republic of Kazakhstan, highlighted the value of regional cooperation particularly given the impacts of climate variability and change on infrastructure and the need for early warning systems to help reduce the risks from hydrometeorological hazards, to promote sustainable development, and to attain and maintain economic prosperity. He also emphasized the need for the international exchange of data and information for improving the provision of forecasts and early warnings, stressing that severe weather events do not confine themselves to national borders. He cited occurrences of the flash flood events in Kazakhstan in this year, explaining that flash floods are very dangerous natural phenomenon in the region. He assured participants that Kazakhstan will provide the necessary support for the implementation and operation of the CARFFG project. He expressed his pleasure in being able to host the SCM 1 in Astana. He welcomed all the participants to Kazakhstan, and he wished everyone a very successful meeting. Mr Alexander LANE, USAID/OFDA Country Director, welcomed everyone to the meeting and was pleased to learn of the advances being made in the implementation of the CARFFGS. He emphasized its importance in enhancing the capacities of NMHSs of the Central Asian Counties for effective early warnings of flash floods. Mr Paul Pilon (WMO) recalled the objectives of the meeting and its expected results, welcomed the participants, and encouraged them to provide their active inputs into shaping this important regional Flash Flood Guidance system project. He also thanked the Kazhydromet for all its efforts including hosting the meeting, thereby helping to make a positive atmosphere that would undoubtedly contribute favorably to the success of the meeting.

The national press covered the meeting extensively. More than ten TV and Newspaper reporters were present. A news conference was held after the opening speeches. Mr Aibek MENDIGARIN, Director General of Kazhydromet and Permanent Representative of Kazakhstan with WMO, informed the press about the objectives and possible outcomes of the meeting and positive impacts of the project on the citizens of the participating countries. Mr Alexander LANE also informed reporters about the USAID/OFDA support being provided for the CARFFG system.

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

SCM 1, which was held Astana, Kazakhstan from 14th to 16th September 2015, was attended by representatives of NMHSs from Kazakhstan, Kyrgyzstan and Tajikistan. Other participants included representatives from WMO, USAID/OFDA, HRC, the Turkish State Meteorological Service (TSMS), the Severe Weather Forecast Demonstration Project (SWFDP)-CA COSMO project, and the World Bank CAHMP project. The list of participants is provided in Annex 1, while the annotated workshop agenda is given in Annex 2.

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

4.1 Responsibilities of the Regional Centre and Participating NMHSs

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

He stated the responsibilities of the participating NMHSs are:

- To have good cooperation, collaboration, communication with the Regional Centre (RC) for the implementation of the CARFFGS;
- To provide historical and in-situ local data to the FFG system developer through the RC (these are specified in Appendix B Data Requirement of CARFFG Implementation Requirements);
- To ensure use of the CARFFG system and its products as a part of your operational hydrometeorological forecasting;
- To prepare and issue flash flood warnings and alerts to the public and national agencies including Emergency Management Authorities;
- To participate in the Flash Flood Hydrometeorological Training Programme-steps 0-5;
- To provide training (Steps 4 and 5) on the CARFFG approaches and products to their local duty/shift forecasters to make best use of the system to forecast hydrometeorological hazards;
- To have close cooperation and collaboration with the national Disaster Management Authorities and to provide them with flash flood forecasts and warnings so that appropriate actions can be taken; and
- To prepare case studies for local flash flood events and conduct verification studies and distributes their results to the RC and HRC.

4.2 Individual Country Presentations

Experts from each country provided in-depth presentations on the current situation of their national services related to hydrometeorological forecasting capabilities, practices and development plans. The presentations are available on the WMO website (www.wmo.int)[1]. The presentations revealed the similarities and differences that exist among the countries regarding their capabilities to deliver weather and flood forecasting and early warnings, especially for those pertaining to flash floods. Countries do not presently have dedicated systems including the use of hydrological modelling to specifically address the provision of flash flood forecasts and warnings.

[1] The link to the material is http://www.wmo.int/pages/prog/hwrp/flood/ffgs/carffg/carffg.php.

4.2.1 Kazakhstan

The expert from Kazakhstan , Mr Talgat Usmanov, provided an overview of the hydrometeorological networks, which consist of 325 meteorological, 9 aerological, 203 agrometeorological stations. Currently, 131 of the 325 meteorological stations are Automatic Weather Stations (AWS), while 83 stations are directly reporting to the WMO Global Telecommunication System (GTS). He then explained the data collection, processing and storage processes in Kazhydromet, stating that observational data collected at each site are transmitted to its regional centres and headquarters using telephone, ratio, internet, and mobile phone.

Ms Sazanova Bayan Aydarkhanovna provided a presentation on the hydrometeorological centre of Kazhydromet, including its administrative structure, short and medium range weather forecasting capabilities, and overall list of forecast and early warning products and services. She stated that there are 14 regional centres in which 73 forecasters are working 7 days a week, 24 hours a day (7/24) providing government authorities and institutions, the media and consumers with information on extreme weather events, as well as actual and expected changes in meteorological conditions. She then explained the end-to-end processes leading to the issuance of early warnings and forecasts and their dissemination to users. She continued to show data collections systems, satellite data reception and processing system, Limited Area Model, specifically WRF model outputs, and weather charts such as surface maps with frontal systems and precipitation forecasts. She provided a list warning products such as extreme weather and sudden weather changes, hydrometeorological bulletins, medium-range forecasts, and specialized weather forecasts which are disseminated to the public, media, and government organizations, including Emergency Management Agency via email, internet, and fax. She concluded by mentioning the use of Climate Predictability Tools (CPTs) for evaluating seasonal climate predictability, thereby estimating the long-term fluctuations of the parameters such as 500 HPa, Sea Surface Temperature and Atlantic Oscillation and their potential impacts within Kazakhstan.

Ms Lidiya Nikiforova explained the existing local capacities of flash floods, floods and mudflow forecasting and early warnings saying that flash floods and mudflows widely occur in the mountains regions of Kazakhstan such as in Alatau (Almaty region) inflicting significant economic damages and human losses.She emphasized that that the implementation of the Central Asia Region Flash Flood Guidance (CARFFG) System would improve flash flood early warning capabilities in the region. She explained the hydrometeorological network in the Almaty region comprises 37 weather and 64 hydrological stations, of which 25 of the meteorological stations and 47 hydrological stations are located in the mountains and foothills. She continued by explaining the methodology used to establish flash flood warnings -- that if precipitation amount exceeds 40 mm flash floods warnings are issued. She mentioned that, on the other hand, should the precipitation amount exceed 20 mm during the snow melt season in March and April below the 1500 meter altitude range, then flash flood warnings are issued. She further explained that mudflow due to glacial melting and heavy rainfall is also a very important cause of the damages and human losses. She showed images of a mudflow event that had taken place on July 25, 2015 in Talgar.

She reviewed the existing hydrological monitoring network in her second presentation. She noted that there are approximately 8,290 streams, 76,000 watersheds, more than 48,000 lakes, and 14 major river basins. She stated that there are a number of transboundary rivers flowing into or from the neighboring countries, making inflow river length 50.7 km and outflow river length 27 km. She concluded her presentation stating that the hydrological monitoring network of Kazhydromet consists of 302 gauging stations, including 258 stream flow stations, 34 lake and reservoir stations, and 10 sea level stations.

Mr Talgat Usmanov provided an overview of the communication network of Kazakhstan. The communication backbone of the Kazaktelecom consists of CISCO systems with 10 Gbyte/s connection to 17 regional centers and 20 Gbyte/s core bandwidth, resulting in very high speed communication. He then cited the benefits of these high speed internet networking that 1) provided highly developed telecommunication infrastructure and branch network for the territory of the Republic of Kazakhstan; 2) resulted from the availability of direct joint ventures with foreign partners and reservation areas through 2-3 alternative operators; 3) provided broad access to the internet with support for the BGP protocol. He also stated that mobile network communication is very advanced, providing reliable GPS/GPRS services. He mentioned that Kazhydromet's observing network is using high speed internet and GPRS communication lines to exchange data.

He continued his presentation saying that Kazhydromet initiated a pilot project to run the Limited Area Model, WRF, on a high performance computer with 64 processors in early 2013. He showed the WRF model products on the Kazhydromet WEB portal and WRF forecast products such as temperature, surface pressure, 850 HPa and 500 HPa pressure fields, winds, precipitation, and Meteograms. He explained that the WRF model runs twice daily at 00 UTC and 12 UTC in four different domains with 18, 13, 4 and 2 km resolutions, covering the participating countries of the CARFFG system. The largest domain covers 35-55^{o}N / 45-80^{o}E with 18 km resolution; second largest domain covers 25-55^{o}N / 30-85^{o}E with 13 km resolution; the 4 km resolution domain covers the mountainous regions of the central Asia region countries (36-44^{o}N / 64-80^{o}E), while the 2 km resolution domain covers only the mountainous regions of Kazakhstan (40-44^{o}N / 75-78^{o}E). He proceeded to show some WRF model products, including surface pressure, winds, precipitation and temperature forecasts and Meteograms with different resolutions. He concluded his presentation showing GIS capabilities of Kazhydromet and various products generated by using GIS such as watersheds and 90 STRM DEM data.

4.2.2 Kyrgyzstan

The expert from Kyrgyzstan, Ms Omorova Elvira Akunova, provided an overview of the climatological characteristics of Kyrgyzstan, showing the distribution of longterm annual precipitation as well as maximum and minimum temperatures. She proceeded to explain the administrative structures of the forecasting and early warning divisions. She indicated that there are: 30 meteorological stations; 77 hydrological stations; 11 agrometeorological stations; 3 snow avalanche stations; 4 Automatic Weather Stations, which were installed in 2002 and funded by USAID; 17 Automatic Weather Stations, which were installed in the years 2014 and 2015 within the framework of the World Bank project called "Promotion of Agribusiness in the Kyrgyz Republic"; 2 Automatic Agrometeorological Stations, which were installed under the UNDP project in the years of 2013 and 2015; and 1 Radiosonde station, which was closed due to lack of maintenance equipment. She explained the data collection, transmission and processing infrastructure and indicated the number of employees working for the IT division.

She continued to provided information on the provision of forecasts and early warnings such that weather forecasts are provided with lead times of 24, 48, and 72 hours in the territory of the Kyrgyzstan Republic and 24 hours in Bishkek and Osh. She noted that storm warnings, special weather forecasts for farmers, monthly forecasts anomalies of air temperature and precipitation, fire, seasonal weather reports, annual reports on the extreme weather events, special reports and bulletins for the radio and television channels are routinely prepared and distributed. She showed weather satellite images produced from METEOSAT-7, FY-2D and polar orbiting NOAA satellites. She explained that forecasters are able to access the Japanese Global Model and ECMWF products. She further articulated that within the scope of the World Bank project called "Promotion of agricultural productivity", the WRF mesoscale model with 5 km resolution was installed in February 2015 and is running twice daily at 00 UTC and 12 UTC. She showed WRF products such as the precipitation forecast, Meteogram, CAPE instability index, maximum reflectivity, and Skew-T Log-P chart. She said that forecasts and warnings are distributed to the Ministries, media and public via e-mail, phone, fax, SMS messages, and Kyrgyz Hydromet WEB portal.

After explaining hydrological forecasting scheme, she stated that both mudflow and flood warnings are issued operationally. She mentioned that 77 hydrological stations are currently operational for river and reservoir monitoring and that hydrological data are processed manually and submitted as a daily bulletin to their Emergency Management Agency.

She stated that historical hydrometeorological data are available on paper and that within the World Bank project called Central Asia Hydro-meteorological Modernization Project, digitization of the paper-based data started in 2013 and that historical hydrometeorological data are available for the period of 1931-2015 on the CliWare database. She concluded her presentation saying that, within the framework of the World Bank project, 33 Automatic Weather Stations (AWS), automated IT systems for the processing and transmission of data, 2 automatic hydrological stations, and an upgrade to the communication system will be implemented in 2016.

4.2.3 Tajikistan

The expert from Tajikistan, Ms Dzhamila BAYDULLOEVA, provided an overview of occurrences of mudflow and floods, stating that Tajikistan is the country in the Central Asia Region that undoubtedly has the most exposure to potential risk from flash floods. This is due to its mountainous terrain such that more than 93% of its territory is covered with mountain ranges with an average height of 3,000 meters above sea level and with a total glacial area of 8,400 square kilometres, covering 8% of the country's territory. She further stated that snow accumulation varies between 2.2 to 6.7 metres during winter in the mountain ranges above the 2000 meter altitude. She provided historical information about the meteorological observational network with the first meteorological station being installed in 1866.

She cited that the steam network of Tajikistan consists of more than 25,000 rivers with a total length of 69,200 kilometres. She indicated that there are 947 rivers with lengths ranging from 10 to 100 km, while there are 16 rivers with lengths ranging from 100 to 500 km. She noted that there were 4 rivers having lengths exceeding 500 km.. She also mentioned that there are five large basins- Zeravshan, Surkhandarya (pp. Karatag Sherkent), Kafirnigan, Vakhsh, and Panj (Gund, Bartang, Yazgulem, Vanj, Kyzylsu-South).

She explained that floods and mudflows are the most hazardous hydrometeorological phenomenon which take place in the foothills of the mountains and in the mountainous regions to 2000 metres height. She stressed that those mudflows, which occur from April to June during the snow melt period, cause socio-economic damages and loss of life.

She cited operational meteorological and hydrological stations and showed their geographical location on maps, specifying that there are 96 stream gauging stations in five major basins, with 89 of them measuring stream levels. She listed the problems in maintaining them, citing lack of trained staff, lack of spare parts, obsolete equipment, and cross-border locations. Then, she showed images of the hydrological stations and stated that the water level, water discharge, air and water temperatures, precipitation, and snow depth were measured.

She showed the snow coverage maps, snowmelt runoff model, and riverine forecasts. Then, she continued to explain that how the operational forecasting for extreme weather events are carried out by using ground data (52 meteorological stations and 30 hydrological stations), synoptic maps, and satellite images (Meteosat) with lead times to 72 hours.

She showed mudflow images in various regions.She explained that mudflows occur in the river basin of Surkhob Obihingou when 35-40 mm of rainfall occur, while in the southern slope of the Hissar Range, mudflows occur when there is 70-80 mm of rainfall. She concluded her presentation saying that mudslides, which occurred in April 1998, damaged 8,500 homes, 1,143 of which were destroyed completely. The total cost of the damages was approximately 60 billion Rubbles.

4.3 Central Asia Hydrological and Meteorological Project (CAHMP)

Mr Kubakov YERDOS, CAHMP project manager, provided an overview of the CAHMP project stating that the project was developed by the World Bank in cooperation with the Executive Committee of the International Fund for Saving the Aral Sea (IFAS). He stated that four Central Asia countries, namely Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan, are participating in the project. He explained that the main objective of the project is to improve the accuracy and timeliness of hydrometeorological services of the Central Asia Region focusing on provision of better public services, economical developments, and improving the social situation. He mentioned that the project started in January 2012 and will finish in August 2016. He then described the project components, indicating that total project cost is US$27.7 million.

He mentioned that component A is designed to strengthen regional cooperation and information exchange, while Components B and C are designed to improve the hydrometeorological services in Kyrgyzstan and Tajikistan. He explained that within the scope of the component A the following activities will be accomplished:1) data processing, visualization, exchange, archiving, and storage of data; 2) provision of training on meteorology, hydrology and climate; 3) improving the quality of the services by providing better weather forecasts and storm warnings, and assessment of climate change; 4) support for the management of the project and to assist by providing consultancy services for integration of activities such as surveillance systems, data collection, processing, analysis and storage of data. He indicated that 169 staff from the NMHSs of the participating countries has been trained until now.

He concluded his presentation by mentioning that the NMHSs of the participating countries will enhance the quality of services by improving weather forecasts, storm warnings and climate change assessments through SWFDP adaptation in the region, generating specific products for specific users, enabling access to the global weather forecasting centres, converting paper based data to digital format, and exchanging meteorological data for IFAS.

4.4 Severe Weather Forecast Demonstration Project-Central Asia (SWFDP-CA)

Consortium for Small-scale Modelling (COSMO[2]) scientist, Dr Gdaliy Rivin, provided an overview of the status of the Severe Weather Forecast Demonstration Project-Central Asia (SWFDP-CA) QPF and the availability of its products to the Central Asia Region Flash Flood Guidance (CARFFG) system. First, he explained that the WMO SWFDP objectives are to: improve the ability of NMHSs to forecast severe weather events; improve the lead time of early warnings; improve the cooperation amongst NMHSs, Disaster Management and Civil Protection Authorities, the media, and different sectors; identify the gaps and areas for improvements; and improve the forecasting skills through feedback from NMHSs. He, then, continued to explain that the cascading exchange of Numerical Weather Prediction (NWP) products, which is the methodological basis of the SWFDP. NWP products from Global NWP centres are provided to the Regional Centres for Limited Area Model (LAM) processing and interpretation, which are, in turn, form the basis upon which to issue early warnings. He said that feedback from the Regional Specialised Meteorological Centres (RSMCs) and NMHSs to Global NWP Centres is extremely important for the development of NWP products, as well as contributing to the exchange of ideas for forecaster training. He further stated that each NMHS should observe the skill

[2] More information on the COSMO model can be found on the COSMO web page www.cosmo-model.org

of NWP forecasts for severe weather events and that training for the forecasters, concerning the optimal use of products, are one of the main components of WMO SWFDP.

He provided an overview of the SWFDP-CA project, specifying that the project started in April 2015 with the participation of NMHSs of Kazakhstan, Kirgizstan, Uzbekistan, and Tajikistan. He noted that the European Centre for Medium Range Weather Forecasts (ECMWF), CMA, KLA, Deutscher Wetterdienst (DWD) and Roshydromet are the NWP centres, while Uzbekistan is the Regional Specialized Meteorological Centre (RSMC). He stated that the main objectives of the SWFDP-CA are to realize the concept of SWFDP for the Central Asia region and to develop the technology of high resolution Limited Area Model (LAM) in the region. He also mentioned that convection processes over flat terrains and the significant influence of high mountains on weather development are the main challenges for severe weather forecasting in the region.

He described the SWFDP-CA portal that contains weather forecasting products such as synoptic maps of the Central Asia region, weather satellite images, interactive alarm, and daily forecasts for the participating NMHSs, and links to the NWP centres. He then proceeded to show some forecasting products such as surface map and associated frontal systems, cloudiness, and meteographs.

Dr Rivin cited the recommended LAM products for the SWFDP project as surface temperature at 2-meter height; wind speed at 10-meter height; maximum and minimum temperatures; gust; surface pressure; cloudiness at mid and low levels; convective cloud base height; snow depth and snow water equivalent; new snow depth for 6 and 24 hours; 925, 850, 700 and 500 hPa levels weather parameters; vertical wind velocities at 850, 700 and 500 hPa levels; instability indices such as K-index, CAPE, CIN, Showalter index, and Skew-t Log-p diagram.

He provided detailed information on the COSMO and COSMO-RU models. He indicated that the new global model called ICOsahedral Nonhydrostatic (ICON) is a joint development project of the German Weather Service (DWD) and the Max-Plank-Institute for Meteorology (MPI-M) for next-generation global Numerical Weather Prediction and Climate Modelling System. It has 13 km grid resolution; 90 vertical layers; and 174-h forecasts period at 00 and 12 UTC, and 78-h forecasts period at 06 and 18 UTC. It has been operational since January 2015, consists of several inner domains such as the European domain with 6.6 km grid space; 60 vertical layers; and forecasts period of 78 hours. Then, he continued to explain the COSMO-RU, stating that it has 7 domains with different grid sizes ranging from 13 km to 1 km; it runs 4 times a day, producing more than 8000 charts and 1000 meteographs; all products are sent to the forecasting centres and the COSMO-RU web portal. He provided information about the research activities saying that main research topics are on data assimilation, pre-processing, ensemble forecasting, post-processing, boundary layer, surface and soil, as well as verification. He then continued to show COSMO-RU products such as surface charts, precipitation fields, and wind fields at various levels, humidity, meteographs, and Skew-t Log-p chart.

He continued by showing a flood event that occurred on 6-7 July 2012 in the city of Kuban located on the Black Sea coast. He indicated that 171 people were killed; 34 600 people were affected; and 5000 houses were destroyed. He said that it was caused by heavy rainfall. Then, he showed COSMO-RU model products such as meteographs with precipitation intensity, temperature, cloud cover and convective clouds. After that, he explained future improvements with different domains including COSMO-Ru2 with 2 km domain that is to run in Tashkent, Uzbekistan.

He conclude his presentation stating that the following activities may be considered to help link SWFDP-CA with CARFFGS: 1) Preparing of initial and boundary data for NWP and preparing flood-cases for the four Central Asian countries; 2) Numerical experiments with COSMO-CA with different grid sizies;3) Hydrological forecasts; 4) Analysis of case studies.

4.4.1 SWFDP-CA and CARFFGS Linkages

COSMO scientist Ms Inna Rozinkina explained the SWFDP-CA main components comprised monitoring the severe weather events, preparing case studies, implementing LAM technology, developing and using the integrated SWFDP-CA web portal, introducing LAM technologies, conducting training, and use of LAM products. She stated the possible areas of joint cooperation between SWFDP-CA and CARFFGS included monitoring of severe weather events including flash floods, developing case studies of heavy precipitation, implementing LAM technologies, references between SWFDP-CA and CARFFGS on web portals, conducting trainings and use of LAM products. She proposed the following joint activities:

- prepare letter from the WMO Secretariat to director-generals of the NMHSs of the SWFDP-CA and CARFFGS participating countries to increase their internet speed;
- provide available data to COSMO-RU in GRIBs format;
- show the flash flood cases in the monitoring lists of SWFDP on http://swfdp-ca.meteoinfo.ru/;
- prepare case studies with COSMO products for mountainous domain with a resolution of 2 km;
- analyze the feasibility of 1-2 days LAM (COSMO) forecasts of heavy rains for flash flood forecasting.

She then provided an overview of the COSMO-RU products, web portal of SWFDP-CA, Meteoalarm, SWFDP-CA components, recommended LAM products for SWFDP, implementation proposal of COSMO-CA, and COSMO-RU products.

Side Meeting

It was considered that linking of the SWFDP-CA and CARFFG System may improve the performance of the flash flood early warnings in the region. Within the scope of World Bank Central Asia Hydrological and Meteorological Project (CAHMP), it was planned that Uzbekistan as a WMO Regional Specialised Meteorological Centre (RSMC) will procure a high performance computer to run high resolution (2.2 x 2.2 km) COSMO model for the mountainous regions of the four participating countries -- Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. The domain is shown in ANNEX IV as dotted lines. The forecast products will consist of meteorological parameters, including precipitation and surface temperature. It is considered that multi-model capability of the CARFFG system, will allow using QPFs from different Limited Area Models (LAM) such as COSMO and WRF.

The following issues are discussed to be taken under consideration for linking of the two systems:

- **Internet speed**: It was mentioned that forecast products are accessed through the internet such that each country must have sufficient bandwidth to access them in a timely manner. It was stated that Kazakhstan has sufficient internet bandwidth, while the other three countries have low internet speed. It is therefore suggested that World Bank consider within the scope of its CAHMP to increase internet bandwidth of Kyrgyzstan, Tajikistan, and Uzbekistan;

- **Provision of initial conditions**: Limited Area Models (LAM) such as COSMO require initial conditions from global models. It was discussed that initial conditions are to be obtained from the German Weather Service (DWD), pre-proceed by the Roshydromet, and then sent in GRIB2[3] format to Tashkent, Uzbekistan to be used in the RSMC's high resolution COSMO model;

[3] **GRIB** (**GRIdded Binary)** is the name of the binary code for the exchange for processed data. **A GUIDE TO THE CODE FORM FM 92-IX Ext. GRIB on http://www.wmo.ch/pages/prog/www/WMOCodes/Guides/GRIB/Introduction_GRIB1-GRIB2.pdf**

- **Domain for the mountain region**: The Hydrologic Research Center (HRC) shall establish the precise domains comprising populated mountainous region for which the RSMC's high resolution COSMO model should run. This information will be provided by th HRC to Roshydromet and the NMHS/RSMC of Uzbekistan;

- **COSMO model for Kazakhstan**: It was suggested that the CARFFG Regional Centre, Kazhydromet, may be encouraged to run a high resolution LAM to provide high resolution QPF for use by the CARFFGS;

- **Hourly precipitation and 2-meter surface temperature data**: It was suggested that hourly precipitation and 2-meter surface temperature forecasts up to 36 hours are needed for ingestion into the CARFFGS; and

- **Case studies for the mountainous regions**: It was recommended that case studies in the mountainous regions should use COSMO model products including QPF, which takes into account the new global model operational capability of DWD.

4.5 Central Asia Region Flash Flood Guidance System (CARFFGS) Training (Step 1)

4.5.1 Flash Flood Guidance System Key Components and Data Requirements

Ms Theresa Modrick of HRC provided an overview of Central Asia Region Flash Flood Guidance System (CARFFGS) products and data needs. She showed the CARFFGS user interface console and touched upon the products by naming them and saying that details will be presented in the following presentations. Then, she continued to explain the key technical components of the CARFFG system: 1) Precipitation data sources, namely satellite, radar, and gauge; 2) Snow model; 3) Soil moisture model; 4) Threshold runoff model; 5) Flash Flood Guidance model; 6) Flash flood threat; 7) Forecasters input; and 8) Mesoscale modelled QPF. She showed the initial basin delineations, saying that they are produced from SRTM-90 m data and should be validated by each country before they are used operationally.

She explained the real-time rainfall processing scheme and merged Mean Aereal Precipitation (merged MAP), specifying that the objective is to produce the best estimate of mean aereal precipitation over each watershed to be ingested into soil and FFG models. She then articulated real-time and historical bias corrections by using in-situ observations and past precipitation data records. She stated that Flash Flood Guidance (FFG) product is computed by using several hydrological models, namely threshold runoff modelling, snow modelling, and soil water modelling.

She concluded her first presentation summarizing the local data received and local data needs for the development and operation of the CARFFGS. She said that Kazhydromet provided historical precipitation, temperature and soil data, while real-time precipitation and temperature data are being received through the GTS. She then emphasized that the following data must be provided to HRC for the development of the system:

- Historical precipitation, temperature and soil data;
- In-situ precipitation and temperature via GTS;
- Local soil and land use data.

CARFFGS data requirements and data priorities are provided in ANNEX IV, while key technical components of the WMO Global Telecommunication System (GTS) are given in ANNEX VI.

4.5.2 CARFFG System Development and Theoretical Background

Ms Modrick explained the development and theoretical background of the CARFFG system in each of the following major categories:1) Special analysis and threshold runoff; 2) Soil moisture, snow and FFG modelling; and 3) Satellite precipitation and bias adjustment. She stated that flash flood basin delineations, which are estimated from quality controlled SRTM-90 metre DEM data, are used for model parameterisation, model computations and product displays and have average drainage areas of 150 square kilometres. She said that results of the delineation are used to compute geometric properties of each watershed, which are used, in turn, for the computation of *Threshold Runoff*[4]. She indicated that this is a constant property of a watershed and that Flash Flood Guidance (FFG) is then estimated from the Threshold Runoff, soil moisture deficit, and evapotranspiration.

She gave an overview of soil moisture, snow and Flash Flood Guidance modelling. She said that the Average Soil Moisture (ASM) product provides an estimate of current soil water in the upper soil depth, expressed as a fraction of saturation. She stated that Sacramento Soil Moisture Accounting (SAC-SMA) model, in which rainfall and snow melt are ingested as input data, is used to estimate ASM. She explained that parameter estimation within the soil model is based on soil texture and soil depth data as provided by the UN Food and Agriculture Organization (FAO). She stated that Snow Accumulation and Ablation Model (SNOW-17) of U.S NWS is employed to estimate Snow Water Equivalent (SWE) and snow melt products for the Central Asia Region. After providing an overview of the snow model, she showed comparisons of modelled SWE and observed snow depth. She then continued to explain the Flash Flood Guidance (FFG) model, specifying that it integrates Threshold Runoff, soil water content, and current precipitation and that it is updated every six hours.

She continued by explaining that satellite precipitation estimates are derived from geostationary and polar orbiting satellites, providing valuable information for the region where ground-based hydrometeorological observations are sparse. She said that Global Hydro Estimator (GHE) precipitation with 4 km resolution is calculated using the Infra-Red (IR) channel, such that the rainfall rate is correlated with cloud top brightness temperature, while microwave precipitation estimate with 8 km resolution is based on backscattering measurements from raindrops in the microwave spectrum. She also mentioned that there is 18-26 hours latency in operation and that GHE is corrected using microwave precipitation data. She finally articulated that two kinds of bias adjustments were employed. The first one is the climatological bias adjustment to determine the long-term bias in satellite precipitation within a given region using historical precipitation observations, while the second one is the dynamic bias adjustment using in-situ observations disseminated through the GTS.

4.5.3 Overview of FFGS Products and Operational Use

Ms Modrick introduced the CARFFG system, design philosophy and FFGS products by explaining their definitions and characteristics. She explained flash flood definitions of various organizations such as WMO and American Meteorological Society (AMS). She listed the natural causes of flash floods as being: 1) intensive rainfall from slow moving thunderstorms or tropical systems; 2) orographic rainfall in steep terrain; 3) soil saturation or impervious land surface; and 4) hydraulic channel properties. She cited the needs, saying that globally flash flooding is one of the deadliest hydrometeorological hazards, and there are very limited capabilities and capacities of the NMHSs to provide timely early warnings. She also explained the differences between riverine floods and flash floods, indicating that each has its own forecasting and early warning features. After explaining the importance of soil moisture on flash flooding, she provided an overview of the FFG fundamental concept, including definition of Flash Flood Guidance (FFG) with its applications; the end-to-end approach for flash flood warnings; and the

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

FFG system components. Finally, she showed the Black Sea and Middle East Flash Flood Guidance (BSMEFFG) user interface and explained the following products:

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

Ms Modrick concluded her third presentation by explaining the snow products generated by the FFGS, namely snow water equivalent (SWE), snow coverage, and the contribution of snow melt (snow MELT). She also showed the CARFFGS user interface console and its products.

4.5.4 Case Study-Black Sea and Middle East FFG (BSMEFFG) System

Mr Yusuf Ulupinar presented a case study on the Hopa flash flood event that took place on 24 August 2015. First, he explained the importance of the flash flood case studies that may help forecasters to understand the behavior of the Flash Flood Guidance System (FFGS) under different atmospheric conditions such as storms associated with synoptic and mesoscale depressions and convection in different seasons. Then, he continued to explain the top-down approach for the preparation of a case study, gvien in the following order: 1) analysis of the diagnostic and prognostic synoptic and mesoscale products such as surface, 850, 700, 500 hPa charts, as well as jet streaks; 2) precipitation forecasts of different NWP products such as ECMWF, ALADIN and WRF; 3) instability analysis including instability indices; 4) satellite and radar images; 5) monitoring of in-situ observations, particularly precipitation intensity and accumulation over time; and 6) analysis of the FFGS products in detail.

He explained that there was a flash flood event in Hopa town located in the Northeast of Turkey on the Black Sea coast. The precipitation started at 06:00 UC on September 24th and lasted until 11:00 UTC (five hours) with an accumulation of 185 mm precipitation. He stated that a surface low pressure centre with a value of 1000 hPa was located in eastern Turkey, while 850 and 500 hPa low centres were located in the eastern Black Sea with geopotential height values of 147 hPa and 573 hPa, respectively at 00 UTC. He showed the instability analysis of the region that indicated the atmosphere was quite unstable. His analysis included such instability indices as K index, TT index and Sweat index that had values of 45, 62 and 425, respectively. Satellite images showed dense cloud cover, while radar indicated heavy rainfall at 09:30 UTC. He mentioned that the 6-hr FFGS values were of 25-40 mm in the vicinity of Hopa town and even 15-25 mm for some other small watersheds at 06:00 UTC. The 24-hr FMAP had values between 100 and 200 mm in the watersheds in the Hopa vicinity at 18:00 UTC on 23 August 2015, while ASM showed that the basins' soils were saturated, with a saturation fraction value varying from 0.85 to 0.90. The Forecast Flash Flood Threat (FFFT), which is an index showing the possible occurances of flash floods, had values between 40-60 mm in Topa Town at 06:00 UTC on 24 August 2015.

He concluded his presentation saying that it was a devastating flash flood event, causing 8 deaths and 27 injuries, while 6 buildings were completely destroyed and 28 buildings were significantly damaged. He indicated that the BSMEFFG system performs very well for flash flood events arising from synoptic scale depressions as was the case for the Hopa town flash flood event.

4.5.5 BSMEFFGS Verification Results

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

4.6 CARFFGS Hydrometeorological Training

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

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

He further articulated that when the training was completed, forecasters should be confident and competent to use FFGS products for flash flood forecasting and the provision of early warnings.

He then explained that it was planned to hold Step 3 specialized training course at HRC, San Diego, CA, USA in February 2016 and that Step 2 eLearning hydrometeorological training (on line course) is a prerequisite for the Step 3 specialized training at HRC. He mentioned that countries should nominated several trainees to take on line courses because they must complete them and pass on-line exams and an exit interview; and that a trainee with the highest score from each NMHS will attend the Step 3 training.

He stated that several on-line course modules such as elements of meteorology, elements of hydrology and flash flood guidance products are being translated into Russian and will be made available on-line by the mid-November 2015.

He further stated that an invitation would be extended toMr Yuri Siminov of Roshydromet to attend the Step 3 training as lecturer.

All country representatives agreed that forecaster training is very important for the successful operation of the CARFFG system and asked if it is possible that two trainees from each participating NMHS be supported to attend the Step 3 training. Mr Jubach replied that CARFFGS training budget is not sufficient to support two trainees from each country as accommodation is quite expensive in San Diego. He did propose that the budget would be sufficient for two trainees if they would be willing to share the same room. It was agreed that two trainees from each county will attend the meeting, and they will share the same room, wherever possible.

4.7 Real-Time Data Dissemination of the Participating NMHSs through WMO Global Telecommunication System (GTS)

The WMO Global Telecommunication System (GTS) is the communication and data management component that allows the World Weather Watch (WWW) to operate through the collection and distribution of information critical to its processes. It is implemented and operated by National Meteorological Services and International Organizations, such as ECMWF and EUMETSAT. As decided by Congress and the Executive Council the GTS also provides telecommunication support to other WMO programmes, facilitating the flow of data and processed products to meet requirements in a timely, reliable and cost-effective way, ensuring that all Members have access to all meteorological and related data, forecasts and alerts. This secured communication network enables real-time exchange of information, critical for forecasting and warnings of hydrometeorological hazards in accordance with approved procedures.

The CARFFGS requires real-time precipitation surface observation data at certain time intervals such as six hours for the bias adjustment processes of the precipitation products and to generate gauge mean areal precipitation (MAP). Surface SYNOP observations including precipitation and temperature are carried out by either manual or automatic meteorological stations in accordance with WMO SYNOP[5] code and made available to the GTS. Each NMHS must have necessary infrastructure hardware and software to disseminate to and access the GTS. More information on the GTS can be found in ANNEX VI.

The Manual on Codes (WMO-No. 306), Volume I contain WMO international codes for meteorological data and other geophysical data relating to meteorology. It constitutes Annex II of the WMO Technical Regulations (WMO-No. 49), Volume I and, therefore, has the status of a Technical Regulation. The Manual on Codes is issued in two volumes with Volume I.1 containing Part A, and Volume I.2 containing Part B and Part C. WMO SYNOP Code format is provided in ANNEX VII of this report.

Volume A[6] contains a complete list of all the surface and upper-air stations in operation, which are used for synoptic purposes. The contents are arranged in the order of the WMO Regions and in index number order within each Region. The regional sections are followed by sections containing stations in the Antarctic and Ocean Weather Stations.

Number of synoptioc stations of the Cenrtarl Asian Contries that are reporting to the GTS are listed in the following tyble, while real-time SYNOP reports obtained from Message Swiching System (MSS) by the Turkish State Meteorological Service (TSMS) are provided in ANNEX VIII of this report.

Country Name	WMO SYNOP Bulletin Header	No of Stations
Kazakhstan	SMKZ20 UAAA 290000	65
Kyrgyzstan	SMKY10 UAFF 290000	7
Uzbekistan	SMUZ10 UTTW 290000	19

[5] Synoptic code, Manual on Codes, International Codes, Volume I.1
[6] WMO Publication no.9, Volume A, Observing Stations and WMO Catalogue of Radiosondes

Tajikistan	SMTA10 UTDD 290000	30
Turkmenistan	SMTR10 UTAA 290000	20
Total		141

Representatives are encouraged to provide the meta-data for their SYNOP stations reporting to GTS in real-time so that the Hydrologic Research Center (HRC) can retrieve and process real-time precipitation and temperature data as well as other surface observations data to assist in flash flood modeling.

4.8 Project Implementation Plan

Mr Paul Pilon described the revised project implementation plan, showing the major tasks, milestones, and schedule. It was stated that Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan have sent Letters of Commitment (LoC) to WMO to participate in the project. It was also stated that Uzbekistan is encouraged to join the CARFFGS activities even though it has not yet sent its LoC to WMO. The following activities were mentioned and had focused discussions on how the process may be sped-up: 1) historical hydrometeorological data to be provided by the end of October; 2) Oon-line courses to be completed by the end of December 2015; 3) CARFFG system to be completed by the end of January 2016; and 4) operational training to be conducted in February, 2016. Participants unanimously agreed on the implementation of the CARFFG system, saying that they would do their utmost to comply with the plan. CARFFGS implementation plan is provided in ANNEX V of this document.

Visit to the Offices of Kazhydromet

During the workshop, participants visited the offices of Kazhydromet to see first-hand the available facilities and infrastructure. Various departments and divisions, including telecommunications, numerical weather prediction, meteorological data processing and data base, weather analysis and forecasting divisions were visited. It was obvious that Kazhydromet has made significant investments on new technology for the modernization of its observational network; data reception, processing and dissemination; numerical weather prediction; and training of its staff. However, it did not have real-time meteorological data processing and visualization software that is very essential to monitor and analyze weather developments for flash flood forecasting. It was recommended though informal discussions that TSMS METCAP+ meteorological data processing and visualization software be provided free of charge to the Kazhydromet to improve its weather analysis and forecasting capabilities. Some features of the METCAP+ are provided in Annex XI of this report.

5. Conclusions from the Steering Committee Meeting 1

1. There was agreement among participants that the development and implementation of the CARFFG system will significantly improve the capabilities of NMHSs in Central Asia to produce timely and accurate warnings of flash flood induced hazards, thereby contributing to disaster risk reduction by saving lives and reducing property damages.

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

3. Participants become familiar the key technical and scientific backgrounds of the CARFFGS developments, including bias adjustments with historical and dynamic precipitation data, soil moisture modelling, threshold runoff modelling, soil accumulation and depletion modelling and flash flood guidance modelling.

4. Participants become familiar with the CARFFGS user interface and its products such as Global Hydro Estimator (GHE), Microwave adjusted GHE, gauge Mean Aereal Precipitation (MAP), merged MAP, Average Soil Moisture, Flash Flood Guidance (FFG), Flash Flood Threats (FFT), Forecast Mean Aereal Precipitation (FMAP), Snow Water Equivalent (SWE), Snow MELT, Mean Aereal Temperature (MAT), and satellite snow coverage.

5. Participants understood the importance of the provision of their historical hydrometeorlogical data to set up model parameters and to conduct the bias corrections and agreed that they will do their utmost to provide readily available hydrometeorological data. It was noted that some of the historical data may be available only on paper so that more time would be needed to make these digitally available.

6. Participants noted the necessity of real-time data reception through the GTS to allow real-time bias precipitation adjustment and use of other surface data in model calculations such as surface temperature data ingestion into snow accumulation and ablation model. They agreed to provide their lists of SYNOP stations reporting to GTS and their Meta data to HRC.

7. Participants noted that use of multiple mesoscale models such as COSMO and WRF may improve the accuracy of the flash flood threats to provide better flash flood warnings. They also noted that use of the high resolution mesoscale QPF in the CARFFG system is extremely important for the mountainous regions. They urged improved linkages between the SWFDP-CA and CARFFGS such that high resolution (2x2 km) COSMO QPF products, covering the mountainous regions of the participating countries, could be used in the CARFFGS.

8. Participants noted that World Bank CAHMP project may improve the hydrometeorlogical hazards early warnings and urged closer cooperation between the CARFFG project and CAHMP project such that Uzbekistan may run the high resolution COSMO model for the mountainous regions of the Central Asia and provide QPF products to the CARFFG system.

9. Participanting countries expressed their desire to have two trainees each attendthe advanced hydrometeorological training to be held at HRC, San Diego, USA. They noted that due to high accommodation costs, they agreed that where feasible, participants would share room accomodations. They also agreed that each county would nominate three or four nominees to take the online courses, which are prerequisite for taking the advanced hydrometeorological training at HRC, such that two with the highest on-line exam grades are to be supported by WMO to attend the training. They expressed their appreciation that on-line courses are available in Russian.

10. Participants agreed on the revised implementation plan and noted the milestones such as provision of historical data, on-line courses, advanced training and system installations, saying that they will contribute to these as much as possible.

11. Participants from Kazhydromet commented that meteorological data processing visualization software such as MECAP+ of TSMS may improve nowcasting and the flash forecasting skill of the Kazhydromet.

6. Closing of the Steering Committee Meeting 1

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

ANNEX I

FIRST STEERING COMMITTEE MEETING (SCM 1)

CENTRAL ASIA REGION FLASH FLOOD GUIDANCE (CARFFG) SYSTEM

Astana, Kazakhstan

14–16 September 2015

List of Participants

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ANNEX II

FIRST STEERING COMMITTEE MEETING (SCM 1)

CENTRAL ASIA REGION FLASH FLOOD GUIDANCE (CARFFG) SYSTEM

Astana, Kazakhstan

14–16 September 2015

Annotated Agenda

Day I

09:30 *Registration*

10:00-10:30 Opening Ceremony

Welcome speeches by the Kazhydromet, WMO, USAID/OFDA representatives

10:30 – 10:45 *Photo session*

10:45-11:00 ***Coffee Break***

11:00 – 11:15 Selection of the session chair and review of the agenda

Participants self-introductions (All)

11:15 – 12:30 Overviews of existing flash flood forecasting and warning infrastructures of NMHSs of the Central Asia Region (CAR) (Country presentations);

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

- Availability of systematically observed hydrometeorological data (availability of the data, digital or paper, periods of coverage),
- Collaborations with emergency management agencies other governmental and non-governmental (private sector, TV, Radio etc.) organizations.
    - Overview of products and services provided.

12:30 – 14:00 Lunch Break

14:00 – 14:30 Responsibilities of the Regional Centre (WMO)

14:30 - 15:00 Kazhydromet capacities in weather and hydrometeorological forecasting, IT, communication etc. (Kazhydromet)

15:00 – 15:15 Responsibilities of the participating NMHSs (WMO)

15:15 – 15:45 Local data requirements & transmission to the Regional Centre (NMHSs)

- Feedback on requirements (NMHSs)

15:45 - 16:00 Project Management Issues (WMO)

16:00 - 16:30 Coffee Break

16:30 - 17:15 *Status and a*vailability of SWFDP-CA QPF for use in CARFFGS (COSMO Scientists)

17:15 – 17:45 World Bank hydrometeorological experiences in the Central Asia region and possible future projects collaborations (CAHMP)

19:00 Welcome dinner

DAY II

09:00 – 09:30 Overview of day I presentations/discussions (All)

09:30 – 11:00 Overview of the Central Asia Region Flash Flood Guidance products (HRC);

- Diagnostic precipitation products (GHE, MWGHE, Merged MAP),
- Prognostic precipitation products (WRF, FMAP),
- Soil Moisture (ASM),
- Flash Flood Guidance (FFGS),
- Threats (IFFT, PFFT, FFFT),
- Snow Products (SCA, SWE, MELT).

11:00 – 11:30 Coffee Break

11:30 – 12:00 CARFFG system development and review of theoretical background (HRC)

- Design Philosophy and Introduction to Modelling Components

- Data Used for Development

12:00 – 12:30 CARFFGS system development and review of theoretical background (HRC) (Continued);

- Spatial GIS Analysis,
- Runoff Estimation.

12:30 – 14:00 Lunch Break

14:00 – 14:30 CARFFG system development and review of theoretical background (Continued) (HRC);

- Soil Moisture Model and Parameterization,
- Snow Model,
- Flash Flood Guidance.

14:30 – 15:00 CARFFG system development and review of theoretical background (continued) (HRC)

- Satellite Precipitation Estimation,
- Precipitation Bias Adjustment Principles.

15:00-15:30 User Interface and Dashboard (Ayhan Sayin)

- Walk-through of Products (view system in real-time),
- Real-time Data Use.

15:45-17:30 Visit to Kazhydromet (to be confirmed)

Day III

09:00 – 09:30 Overview of previous day presentations/discussions (All)

09:30 – 10:30 Operational FFG products usage (Case studies) (Yusuf Ulupinar,Ayhan Sayin); Participants will be involved.

- Synoptic and mesoscale analysis,
- FFG products and preparations of bulletins,
- Detailed discussion of examples,
- Validation Methodology and BSMEFFGS 2014 validation results.

10:30 – 11:00 Coffee Break

11:00-12:00 Advances in FFGS (HRC)

- Landslides
- Urban flooding early warning system
- Mud/debris flow (All)

12:00 – 12:30 Possible points od collaborations between SWFDP and CARFFGS

12:30 – 14:00 Lunch Break

14:00 – 14:30 Review of Work Plan

- Adjustments and next steps

14:30 – 15:30 Final Discussions, conclusion and recommendation for further development (All)

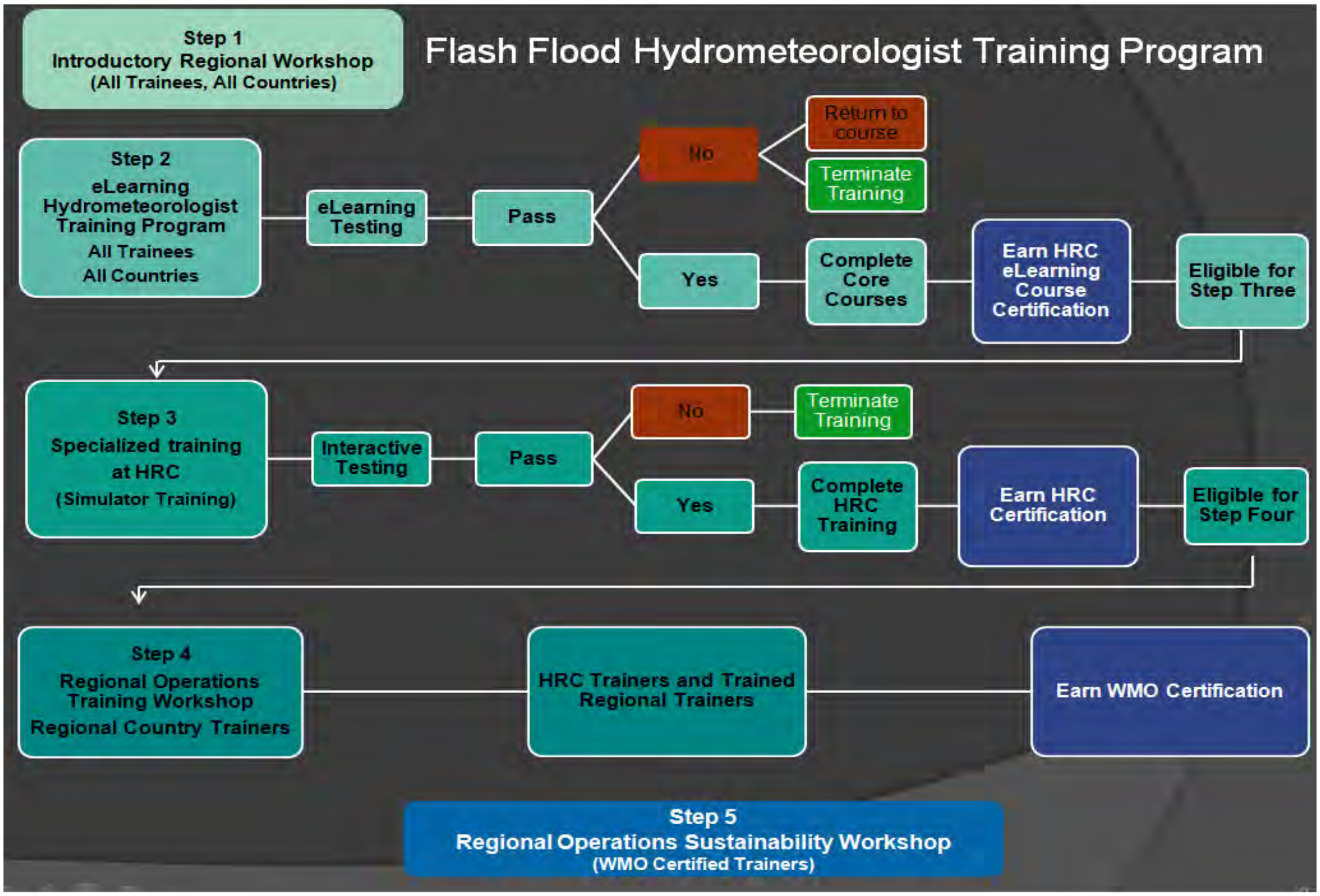
15:30 Closing statements & closure of the meeting

-End of Workshop-

ANNEX III

Flash Flood Hydrometeorological Training Programme

An ongoing regional training program involving the Centres will be developed to maintain proficiency with system operations, ensure continued system validation, and ensure continued system use and ownership. This will involve continual engagement with the community of users. Tools will be developed to build capacity to improve the system and handle more complex contingency scenarios (e.g. key data missing, failure in "normal" operations, communications, or other such events).



ANNEX IV

Data Requirements

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

A. NMHS Capacity Information

Institutional capacities, responsibilities:

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

B. Spatial GIS Data, Maps

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

C. Spatial GIS Data, Maps

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

- Precipitation (hourly, daily, monthly), covering at least past 5 years as much as available;
- Surface air temperature (hourly, daily, monthly);
- Top soil moisture (daily, weekly, monthly);
- Streamflow discharge for local streams with drainage areas less than 2000 km^2 (hourly, daily, monthly);If streamflow discharge data are unavailable, stream stage data (hourly, daily, monthly) and associated stage-discharge curves (rating curves), also for local streams;

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

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

D. Real-Time Data Requirements

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

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

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

NMHS Observation Network Metadata Requirements

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

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

ANNEX V

Data Priorities for the CARFFG System

REAL-TIME DATA

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

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

+ Meta data includes station name &/or identifier, coordinates in LAT/LON, and elevation
** Precipitation, temperature, and snow observations may be used directly by system. Soil moisture, stream flow and other meteorological observations (frequent less available)*
are provided as information through system interface and may be used by forecaster to evaluate certain system output products.

HISTORICAL DATA

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

(1) FOR ANALYSIS PERIOD OVERLAPPING SATELLITE ESTIMATES:
1.a) PRECIPITATION BIAS ANALYSIS

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

** Gauges with good spatial coverage and relatively uniform density across country. Quality*
controlled data is required. Typically, most information is available from daily reporting stations.
+ Meta data includes station name &/or identifier, coordinates in LAT/LON, and elevation.

1.b) Hydrologic Model Calibration

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

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

1.c) Hydrologic Model Calibration – Spatial Data

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

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

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

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

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

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

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

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

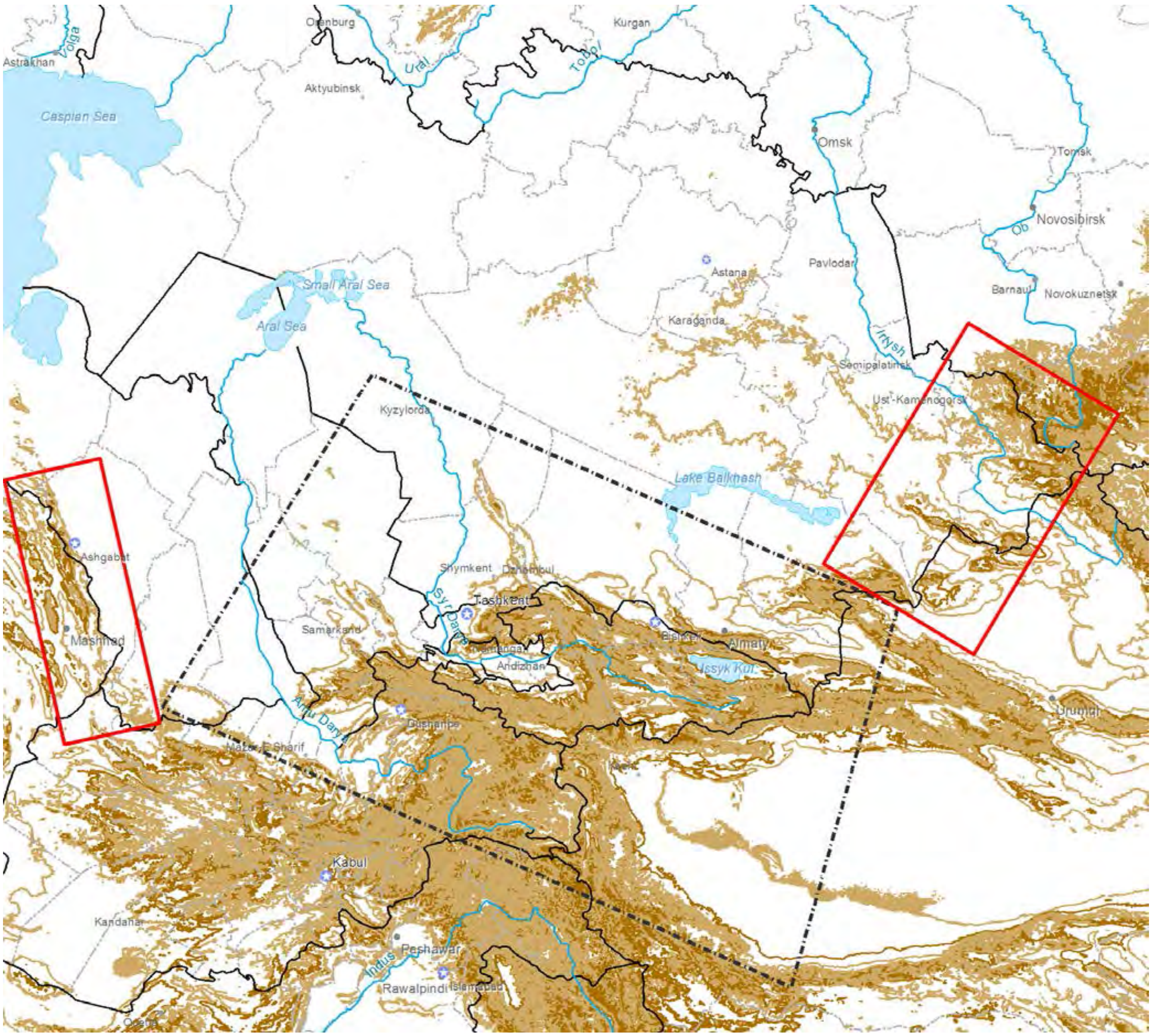
(3) ADDITIONAL HISTORICAL STUDIES

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

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

ANNEX VI

Map of Central Asia indicating required High Resolution Domains



ANNEX VII

Milestones for the CARFFGS Implementation Plan

CENTRAL ASIA FFGS IMPLEMENTATION

TASK NAME	2015								2016							
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Planning Meeting	DONE															
Server Purchase - Regional Center	DONE															
Letters of commitment and points of contact provided																
Obtain static and historical hydromet data																
Obtain real-time data information - data availability/access																
Training Workshop - Step 1 (Steering Committee Meeting #1)																
National/Regional Centers complete online courses - Step 2																
Complete system development																
Regional Center develop and provide real-time data format rqmt																
Regional Center operational (to collect real-time data)																
National Centers operational and provide real-time data access																
Complete operational training at HRC - Step 3																
Steering Committee Meeting #2																
Regional Operations Workshop																
Onsite system installation at Regional Center																
Operations workshop - Step 4 (Steering Committee Meeting #3)																

The WMO Global Telecommunication System (GTS)

The Global Telecommunication System (GTS) is defined as: "The co-ordinated global system of telecommunication facilities and arrangements for the rapid collection, exchange and distribution of observations and processed information within the framework of the World Weather Watch."

WMO No 49 Technical Regulations

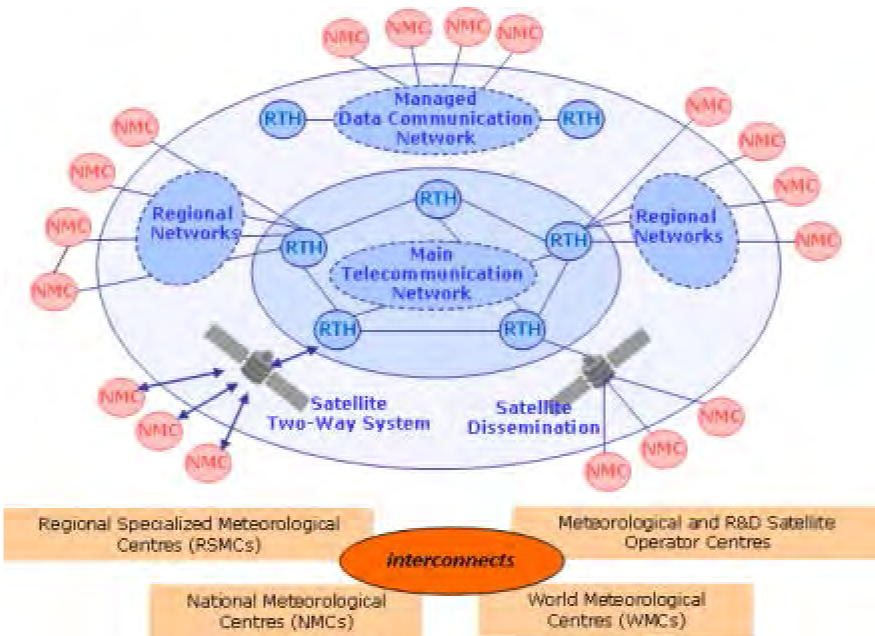


FIGURE 1 - Structure of the Global Telecommunication System

WMO's Global Telecommunication System (GTS) is the communications and data management component that allows the World Weather Watch (WWW) to operate through the collection and distribution of information critical to its processes. It is implemented and operated by National Meteorological Services of WMO Members and International Organizations, such as ECMWF and EUMETSAT. As decided by Congress and the Executive Council the GTS also provides telecommunication support to other WMO programmes, facilitating the flow of data and processed products to meet requirements in a timely, reliable and cost-effective way, ensuring that all Members have access to all meteorological and related data, forecasts and alerts. This secured communication network enables real-time exchange of information, critical for forecasting and warnings of hydrometeorological hazards in accordance with approved procedures.

The GTS has a hierarchical structure on three levels:

The Main Telecommunication Network (MTN), linking together three World Meteorological Centres (WMCs) (Melbourne, Moscow and Washington) and 15 Regional Telecommunication Hubs (RTHs) (Algiers, Beijing, Bracknell, Brasilia, Buenos Aires, Cairo, Dakar, Jeddah, Nairobi, New Delhi, Offenbach, Toulouse, Prague, Sofia and Tokyo) see Figure 1. This core network has the function of providing an efficient, rapid and reliable communication service between the Meteorological Telecommunication Centres (MTCs).

The Regional Meteorological Telecommunication Networks (RMTNs) is an integrated network of circuits covering the six WMO regions - Africa, Asia, South America, North America, Central America and the Caribbean, South-West Pacific, Europe and Antarctic - and interconnecting the MTCs thus ensuring the collection of observational data and regional selective distribution of meteorological and other related information to Members. Until the integrated network is completed, HF-radio-broadcasts may be used in order to meet the requirements of the WWW for the dissemination of meteorological information.

The National Meteorological Telecommunication Networks (NMTNs) enable the National Meteorological Centres (NMCs) to collect observational data and receive and distribute meteorological information on a national level.

Satellite-based data collection and/or data distribution systems are also integrated in the GTS as an essential element of the global, regional and national levels of the GTS. Data collection systems operated via geostationary or near-polar orbiting meteorological/environmental satellites, including ARGOS, are widely used for the collection of observational data from Data Collection Platforms. Marine data are also collected through the International Maritime Mobile Service and through INMARSAT. International data distribution systems operated either via meteorological satellites such as the Meteorological Data Distribution (MDD) of METEOSAT, or via telecommunication satellites, such as RETIM or FAX-E via EUTELSAT are efficiently complementing the point-to-point GTS circuits. Several Countries, including Argentina, Canada, China, France, India, Indonesia, Mexico, Saudi Arabia, Thailand and the USA, have implemented satellite-based multi-point telecommunication systems for their national Meteorological Telecommunication Network.

The MTCs function is to accommodate the volume of meteorological information and its transmission within the required time limits for global and interregional exchange of observational data, processed information and any other data required by its Members. Regional Telecommunication Hubs (RTHs) on the MTN perform an interface function between the RMTNs and the MTN.

The GTS is an integrated network of surface-based and satellite-based telecommunication links of point-to-point circuits, and multi-point circuits, interconnecting meteorological telecommunication centres operated by countries for round-the-clock reliable and near-real-time collection and distribution of all meteorological and related data, forecasts and alerts. This secured communication network enables real-time exchange of information, critical for forecasting and warning of hydrometeorological hazards.

WMO GTS is the backbone system for global exchange of data and information in support of multi-hazard, multipurpose early warning systems, including all meteorological and related data; weather, water and climate analyses and forecasts; tsunami related information and warnings, and seismic parametric data. WMO is building on its GTS to achieve an overarching WMO Information System (WIS), enabling systematic access, retrieval, and dissemination and exchange of data and information of all WMO and related international Programmes.

WMO SYNOP Code Format

b. LIST OF CODE FORMS WITH NOTES AND REGULATIONS

FM 12–XIV Ext. SYNOP **Report of surface observation from a fixed land station**

FM 13–XIV Ext. SHIP **Report of surface observation from a sea station**

FM 14–XIV Ext. SYNOP MOBIL **Report of surface observation from a mobile land station**

C O D E F O R M :

SECTION 0 $M_iM_iM_jM_j$ { D . . . . D**** or $A_1b_wn_bn_bn_b$** } $YYGGi_w$ { IIiii* or $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$**** } $MMMU_{La}U_{Lo}$*** $h_0h_0h_0h_0i_m$***

SECTION 1 i_Ri_xhVV Nddff (00fff) $1s_nTTT$ { $2s_nT_dT_dT_d$ or 29UUU } $3P_0P_0P_0P_0$

{ 4PPPP or $4a_3hhh$ } 5appp $6RRRt_R$ { $7wwW_1W_2$ or $7w_aw_aW_{a1}W_{a2}$ } $8N_hC_LC_MC_H$ 9GGgg

SECTION 2 $222D_sv_s$ $(0s_sT_wT_wT_w)$ $(1P_{wa}P_{wa}H_{wa}H_{wa})$ $(2P_wP_wH_wH_w)$ $((3d_{w1}d_{w1}d_{w2}d_{w2})$

$(4P_{w1}P_{w1}H_{w1}H_{w1})$ $(5P_{w2}P_{w2}H_{w2}H_{w2}))$ ({ $6I_sE_sE_sR_s$ or ICING + plain language })

$(70H_{wa}H_{wa}H_{wa})$ $(8s_wT_bT_bT_b)$ (ICE + { $c_iS_ib_iD_iz_i$ or plain language })

SECTION 3 333 (0 . . . .) $(1s_nT_xT_xT_x)$ $(2s_nT_nT_nT_n)$ (3Ejjj) (4E´sss) $(5j_1j_2j_3j_4\ (j_5j_6j_7j_8j_9))$

$(6RRRt_R)$ $(7R_{24}R_{24}R_{24}R_{24})$ $(8N_sCh_sh_s)$ $(9S_PS_Ps_ps_p)$

(80000 (0 . . . .) (1 . . . .) . . . .)

SECTION 4 444 $N'C'H'H'C_t$

SECTION 5 555 Groups to be developed nationally

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* Used in FM 12 only.

** Used in FM 13 only.

*** Used in FM 14 only.

ANNEX X

Central Asia Region WMO SYNOP reports to GTS

County Name	SYNOP Bulletin Header		SYNOP Report
Turkmenistan	**SMTR10 UTAA 290000**	**AAXX 29001**	38388 42998 00000 10114 20009 30155 40226 58001 555 18009=
			38392 42997 00103 10115 21007 30136 40238 54000 555 10009=
			38507 42996 20907 10192 20038 30106 40204 54000 80001 555 10017=
			38511 42998 00000 10130 20040 30085 40224 58006 555 10012=
			38545 42998 00000 10103 20040 30035 40208 52002 555 10010=
			38647 42997 01004 10156 20034 30154 40195 57002 555 10013=
			38656 42998 00202 10156 20004 30098 40205 57003 555 10013=
			38687 42796 23603 10134 20056 39946 40176 58008 82500 555 10012=
			38750 42997 01402 10188 20078 30210 40183 57004 555 10020=
			38763 42997 00903 10158 20058 30100 40202 58004 555 10014=
			38774 42997 00801 10151 20065 30015 40205 57014 555 10010=
			38799 42997 00000 10108 20036 39947 40175 58011 555 10010=
			38806 42997 00000 10103 20070 39918 40176 57001 555 10009=
			38880 42997 02302 10170 20030 39958 40206 56003 555 10014=
			38886 42997 03002 10122 20032 39979 40204 53005 555 10011=
			38895 42996 00000 10110 20058 39900 40185 57004 555 10011=
			38911 42997 02403 10124 20053 39882 40172 57002 555 10013=
			38915 42997 00000 10124 20013 39859 40177 53003 555 10013=
			38974 42998 02703 10160 20027 39853 40178 57006 555 10015=
			38987 42996 02401 10105 20002 39472 40209 54000 555 10005=
Uzbekistan	**SMUZ10 UTTW 290000**	**AAXX 29001**	38141 42998 00712 10080 20030 30120 40278 58005 555 10006=
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			38178 429// 00103 10063 21044 39959 40245 57001 555 10004=
			38262 429// 03603 10058 21015 30160 40243 58003 555 10003=
			38264 42998 00203 10086 21078 30156 40250 54000 333 00008 555 10007=
			38396 42997 00402 10099 21033 30112 40236 52002 333 00009 555 10009=
			38403 429// 00203 10114 20012 30093 40212 54000 555 10009=
			38413 429// 01501 10113 21041 39967 40254 58003 555 10009=
			38457 42997 00602 10110 20058 39622 40198 57002 555 10006=
			38462 NIL=
			38565 329// 00000 10103 20017 39625 40201 58006 555 10008=
			38579 329// 10000 10112 20062 39786 40197 57002 81040 333 00007 555 10007=
			38583 32997 22301 10079 20045 39885 40205 57002 80001 333 00005 555 10007=
			38611 42997 43203 10147 20056 39653 40207 57002 84040 333 00014 555 10013=
			38618 429// 00802 10133 20067 39520 40191 52002 333 00009 555 10010=
			38683 42997 03605 10126 20043 39909 40179 57004 333 00/// 555 10012=
			38696 329// 00701 10112 20032 39362 40203 57002 555 10008=
			38812 42997 00901 10124 20025 39718 40162 57005 555 10008=
			38927 32960 02101 10096 20056 39803 40175 53008 555 10009=
Tajikistan	**SMTA10 UTDD 290000**	**AAXX 29001**	38598 429// 00000 10102 20073 40210 52002=
			38599 42998 22702 10127 20039 39698 40202 53006 80001=
			38705 429// 00000 10084 21054 39053 48530 52004=
			38713 42984 01402 10102 20004 39061 48530 57008=
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			36982 429// 20701 11115 21144 36601 47232 53007 82030=
Kazakhstan	**SMKZ20 UAAA 290000**	**AAXX 29001**	28978 425// 62304 10074 21041 39836 40321 57006 85501 555 10004=
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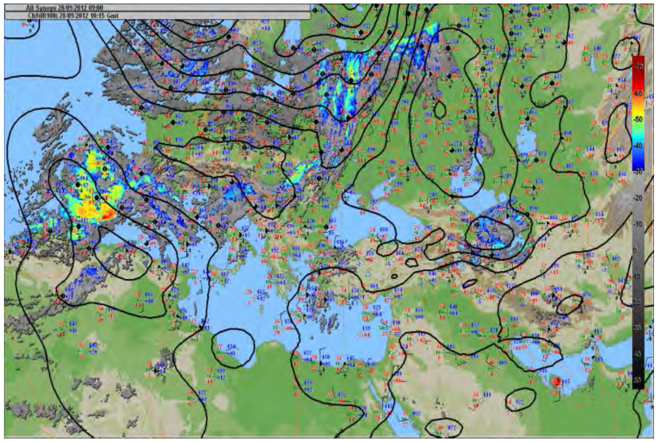
			38334 42998 00404 10078 21007 39303 40250 53001 555 10005=
			38341 42997 00000 10008 21035 39506 40303 53007 555 10000 91112=
			38343 42997 00000 11010 21042 39450 40310 53002=
			38439 42998 03504 10080 21022 39869 40202 57008 555 10007=

ANNEX XI

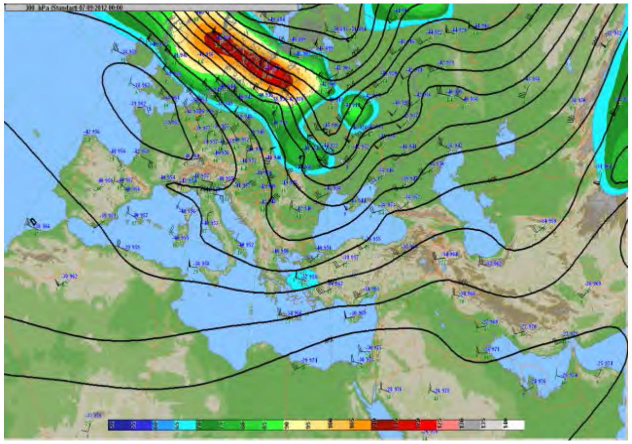
TSMS Meteorological Data Processing and Visualization Software (METCAP+)

Some features of the METCAP+ are as follows:

- Developed to display and combine huge amount of meteorological data from observations, Satellite, Radar and NWP on the same screen,
- Main Visualisation Software of TSMS used by regional forecasting centers and airports,
- Development of new version,
- Decodes bulletins received in FM 12 and BUFR format,
- Standard or user defined plottings,
- Changing plot density, observation size,
- Plotting with some limitations,
- Regional plot,
- Climatological actuel data comparison,
- Weather summary with icons,
- Contouring different parameters,
- Observing change in any parameter for a selected time interval,
- Standart levels 1000-100hPa,
- Tropopose Max Wind,
- Thickness for different levels,
- Subsidence,
- Different Indices,
- NWP data created by different centers are used to generate different products,
- ECMWF data is used to generate meteograms for any point,
- GFS data from NOAA are automatically downloaded and displayed,
- Data from different centers may be overlayed on the same chart.



Surface and METEOSAT Image superimposed



300 hPa Geopotential Height and Jet Stream superimposed