Nay Pyi Taw, Myanmar
27-29 September

2016

9th South Asian Seasonal Climate Outlook Forum (SASCOF 9)

&

2nd Climate Services Users Forum for Agriculture (CSUF-Ag2)

DMH: Department of Meteorology and Hydrology, Myanmar
RIMES: Regional Integrated Multi-Hazard Early-warning System for Africa and Asia

GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui de

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Acknowledgement

The organizers of the event would like to acknowledge the generous support provided by many institutions and individuals who shared their expertise and experience during the event. The organizers are grateful to Honourable Deputy Minister Mr. Kyaw Myo, Ministry of Transport and Communications, Myanmar and Dr. Rupa Kumar Kolli, Chief, World Climate Application and Service, World Meteorological Organization (WMO), Switzerland for their gracious presence at the opening session of the event.

The event was not possible without the help of National Meteorological and Hydrological Services of participating South Asian countries. We highly appreciate the presence of representative from Bangladesh Meteorological Department (BMD); Department of Hydro-Meteorological Services (DHMS), Bhutan; Regional Meteorological Centre, Chennai, India; Maldives Meteorological Service; Department of Hydrology and Meteorology (DHM), Nepal; Pakistan Meteorological Department (PMD) and Department of Meteorology, Sri Lanka.

The organizer would also like to express our thanks to representative from Bangladesh Rice Research Institute (BRRI); Department of Agriculture, Bhutan; Central Research Institute for Dryland Agriculture (CRIDA), India; Ministry of Fisheries and Agriculture, Maldives; Ministry of Agriculture Development, Nepal and University of Agriculture, Faisalabad, Pakistan for successfully conducting the Climate Service User Forum for Agriculture.

We deeply appreciate the contribution of various resource persons from the Bureau of Meteorology(BoM), Australia; China Meteorological Administration (CMA); Indian Institute of Tropical Meteorology (IITM), Pune, India; India Meteorological Department (IMD), Tokyo Climate Center (TCC), Japan; Korea Meteorological Administration (KMA), Department of Meteorology, Sri Lanka; Met Office Hadley Centre, UK.

Last but not least, we would like to gratefully acknowledge the Environment and Climate Change Canada for providing financial support for these events through World Meteorological Organization (WMO)'s Programme for Implementing Global Framework for Climate Services (GFCS) at Regional and National Levels.

Opening

The 9th session of the South Asian Climate Outlook Forum (SASCOF 9) started with opening remarks by the Guest Speaker Honourable Deputy Minister Mr. Kyaw Myo, followed by Dr. G. Srinivasan, Chief Scientist RIMES, and Dr. Rupa Kumar Kolli, Chief, World Climate Application and Services Division, World Meteorological Organization (WMO), Geneva.

Speakers at the opening session highlighted the SASCOF process and its benefits to the national meteorological services and their stakeholder agencies, with particular reference to the agricultural sector. SASCOF 1 was started in 2010 and since then it is being held regularly every year, and twice yearly since last year with continued support from the World Meteorological Organization (WMO). The seasonal nature of rains over Southern Asia make agriculture and water resources highly dependent on climate variability and each participating country has its own unique examples to share. The fact that the event aims to bring together two important groups - the seasonal forecasters and its users from the agricultural sector was also highlighted.

Seasonal forecasts are probabilistic, so they need to be carefully interpreted to sector specific decision contexts and risk limits. A participatory process like a "climate outlook forum" therefore provides an ideal platform to enhance the understanding and uptake of the available climate information on different time-scales. There was an emphasis on the need to create lasting mechanisms and institutional linkages that enable a cascade of such information up to the last layer of actual risk management decision makers.

Session 1A:

Winter Climate over South Asian Region

The Session began with a general discussion on the "Winter Climate over south Asian region". Mr. Kariyawasam, former Director General, DoM, Sri Lanka presented an overview of the winter season climate of the region as a whole.

He discussed circulation patterns and the large-scale drivers for the winter monsoon and the influence of western disturbances and their role in driving weather in northern part of the south Asian region. He discussed the climatology of major cities including Kabul, Islamabad, New Delhi, Dhaka, Paro, Yangon, Male and Trincomalee. He also mentioned about the rainfall characteristics in the Southern peninsular India and Sri Lanka, which do receive heavy rain during the winter monsoon. The two main cyclone seasons in the Bay of Bengal are from April-May and October-November period. Severe Tropical Cyclones cannot develop during the summer monsoon season largely because of the strong vertical wind shear. This was illustrated by the 110 years of cyclone tracks in the Northern Indian Ocean, Bay of Bengal and the north-western Indian Ocean where about 3.5 storms form on an average.

He added that during the 2015 winter season, strong El Niño conditions prevailed and as a result, there was less cyclonic development particularly in the east and south central Bay. Instead, a few cyclonic systems developed in the southwest bay, close to Sri Lanka and Southern peninsula but, none of them reached to the tropical cyclone strength

there itself. As they were at their formative stage, they produced very heavy rain over southern peninsula and Sri Lanka.

Beijing Climate Center (BCC), China Meteorological Administration

Dr. Liu, representing BCC started the discussion with a comparison of the two of the strongest El Niño events in the past two decades. The 1997-98 event and the 2015-16 and discussing the characteristics of the Niño3.4 southern oscillation index (SOI) during both these events. He then, explained about the evolution of the BCC Climate System Model (CSM) AGCM-2.2 model a coupled model, with horizontal resolution of 110 km (T106, L26) with a prediction lead time of 13 months and 15 LAF members and base period is from 1991-2013.

The skill (Anomaly correlation co-efficient) of the model suggests highest skill over the tropics for 500 hPa geo-potential height. In the middle latitudes, the high skills are favored over the areas mainly influenced by ENSO. Positive skills over the south Asian region for 2m temperature for SON (September, October & November) and DJF(December, January & February) and very low skill for rainfall over the same region and period. He discussed the new generation ENSO prediction system being used at BCC since 2012-2015 in experimental mode with statistical prediction method with both independent and cross validation methods.

Sea Surface Temperature (SST) Prediction: The weak cold condition over the equatorial central Pacific in October, November & December (OND) will get weakened in (December, January & February) DJF and the Indian Ocean will mainly keep warmer in OND and DJF.

T2m Prediction (Surface air temperatures at 2 meters height): Above normal temperature is favored over the northern part of South Asia during OND and DJF, especially over Myanmar, Bangladesh, NE India, Bhutan and Afghanistan while few areas will receive below normal temperature. Southern India and Sri Lanka will experience normal temperatures.

Rainfall: Below normal rainfall will be favored over Afghanistan, north-eastern and southern India and Sri Lanka. Except the above areas, the rainfall prediction is near normal during OND and DJF.

He summarized, that ENSO to be neutral and weak cold during the winter; Temperature forecast for a warmer Myanmar, Bangladesh, North East India, Bhutan and Afghanistan and Normal Southern India and Sri Lanka and Rainfall prediction for a drier Myanmar, Afghanistan, north eastern and southern India, Sri Lanka.

Tokyo Climate Centre (TCC), Japan Meteorological Agency (JMA)

Mr. Shoji from the Tokyo climate centre presented on the climate predictions from the TCC and started the discussion with the overview of the boreal winter of 2015-16 with a comparison of the analysis, forecast and composite of the El-Niño during the 1981-2010 period done for the sea surface temperature and the 200hPa velocity potential. He then, discussed about JMA's seasonal prediction system (MRI-CPS2), with a horizontal resolution of 110km (TL159) and with a lead time of 7 months updated 20th of every month. Though the model shows good skill for temperature, the skill is relatively low for precipitation. He then discussed the current oceanic condition and different indices including the SOI and SST for the Niño 3 regions.

He summarized the prediction of the winter 2016-17 as near normal rainfall (area averaged precipitation anomalies) for south Asian region (ACC=0.47 for OND and 0.26 for DJF). The most likely category will be below normal over the northern part of South Asia and above normal in and around the Bay of Bengal from October 2016 to February 2017. La Niña conditions are present in the equatorial Pacific and with likelihood that such conditions would persist through boreal winter (70%). Further, it is also likely that the Indian Ocean Basin Wide SST (IOBW) will be near normal until boreal winter. Temperatures were expected to be near normal in southern part of South Asia, and above normal in inland part of South Asia, while below-normal in the Indochina Peninsula.

WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (WMO LC-LRFMME), Korea Meteorological Administration (KMA)

The WMO lead center presentation by Ms. Gayoung Kim highlighted the role and the products available from the lead center and MME prediction methods developed. Access levels to products vary; and remain limited to Global Producing Centers (GPCs), Regional Climate Centers (RCCs), National Meteorological and Hydrological Services (NMHSs) and bodies coordinating Regional Climate Outlook Forums (RCOFs). She then described the oceanic condition for the past 3 months which showed neutral to La Niña like condition. On the winter outlook prediction for 2016-17 from the lead center, she mentioned about a neutral to weak La Niña (<-0.5˚C) is expected during boreal winter 2016/17 while DMI is expected to be negative condition during the winter season.

She also explained the see-saw pattern in the Indian Ocean (high SLP in the west/low SLP in the East) and a negative IOD induced circulation pattern over Indian Ocean that is expected to dominant during OND 2016. The MME prediction skills of 2m temperature for OND season are good and most parts of India and Myanmar are expected to be a near-normal condition. While Southern parts of India, Sri Lanka, Nepal, Bangladesh and Pakistan are expected to be above-normal condition. She concluded with the OND 2016 being below-than-normal conditions over Pakistan and DJF 2016/17: below-than-normal conditions over Nepal.

UK Meteorological Office (UK Met Office)

Dr. Colman, started his presentation with a short introduction on the current SST condition, which echoed the earlier presenters, about a cooler east pacific and Indian Ocean. He then moved on to the UK Met office's GloSEA5 operational seasonal forecasting model with the atmosphere (~60km) and ocean (0.25 degree) resolution.

Moving towards the outlook he did mention about the limitation on the skill of the model in the region especially for precipitation, but for temperature GloSea5 showed good correlation. The model is suggested more confidence in an above normal temperature over the region. He discussed, in detail the skill scores (ROC) with a combination of calibrated and un-calibrated forecast for OND and DJF for both wet and dry tercile category.

Finally, he summarized describing the GloSea5 temperature skill as being good in the southern parts of the region. The OND forecast indicated above normal temperatures around the Bay of Bengal in an otherwise mostly normal outlook over the whole region. DJF forecast is mostly above normal across the region, while keeping in mind about the Glosea5 rainfall skill generally low and calibration does improve OND skill in parts but not

DJF skill. The OND forecast is below normal over Maldives, Sri Lanka, NE Myanmar, wet in between and DJF forecast is expected to be below over North East Myanmar, normal around Sri Lanka, Maldives, above normal over most of India.

Summary of climate outlook from the global centers

Regional Centre	Precipitation	2m Temperature	SST
BCC	▪ ***Drier****:* Myanmar, Afghanistan, north eastern and southern India, Sri Lanka	▪ Warmer Myanmar, Bangladesh, NE India, Bhutan and Afghanistan ▪ Normal: Southern India and Sri Lanka	▪ Neutral and weak cold conditions are favored during the winter. (ENSO)
TCC	▪ South Asia is expected to be near normal ▪ Most likely category will be below normal over the northern part of South Asia ▪ Above normal in and around the Bay of Bengal	▪ Near normal in southern part of South Asia. ▪ Above normal in inland part of South Asia. ▪ Below-normal in the Indochina Peninsula	▪ La Niña conditions are present in the equatorial Pacific ▪ La Niña conditions winter (70%). ▪ the Indian Ocean Basin Wide SST (IOBW) will be near normal until boreal winter
WMO_LC LRFMME	▪ OND 2016: below-than-normal (Pakistan) ▪ DJF 2016/17: below-than-normal (Nepal, some parts of Thailand and Malaysia)	▪ OND 2016: warmer-than-normal (Southern parts of India, Nepal, Bangladesh and Pakistan) ▪ DJF 2016/17: warmer-than-normal (most regions)	▪ ENSO prediction ▪ Cool-neutral (>-0.5 ˚C) is expected during winter 2016/17 ▪ IOD -Negative condition through the wintertime
UK-Met	▪ OND-Below over Maldives, Sri Lanka, NE Myanmar, wet in between ▪ DJF - Below over NE Myanmar, normal around Sri Lanka and Maldives, above over most of India	▪ GloSea5 temperature skillgood in South of region ▪ OND forecast: Above normal around Bay of Bengal otherwise mostly normal ▪ DJF forecast: Mostly above normal across region	▪ Slightly IO Normal over Northern IO and Normal others

Session 1B:

Country Presentations

Bangladesh

Ms. Nayma from Bangladesh Meteorological Department briefed about the rainfall and Temperature patterns of Bangladesh and prediction for the period of the winter season. She introduced a wide range of information related to observation facilities, status for LRF (Long Range Forecast), climatology and impact of climate change in Bangladesh. As she explained about the temperature condition of October to February, she pointed out that October to November is considered as a transition period and January is the coldest month in Bangladesh. Average minimum temperature varies from 10°C to 12°Cin the Northwestern and Northeastern part of the country, reaches 15° to 17°C in the coastal areas. In late December and early January, the minimum temperature in the extreme North part of the country reaches up to 4°-7°C.

According to the special distribution and statistical analysis, the amount of rainfall and the number of cold days is gradually decreasing. So in upcoming year country was expected to receive less amount of rainfall and the intensity of winter will decrease and the number of cold days will be less compared to the previous years.

Bhutan

Mr. Tayba from the department of Hydro-Met Services, Bhutan comprehensively presented the outlook for the winter season. He started with a brief about the climate of Bhutan which is generally dominated by monsoon winds with dry winter and wet summer monsoon.

Bhutan used CPT (Climate Predictability Tool) for both verification and then he discussed on the verification of winter, overall last winter monsoon forecast for Bhutan was Normal and actual rainfall for last winter season was below Normal in Bhutan. During the discussions, it emerged that because the rainfall contribution by the winter months is insignificant as compared to the annual total rainfall and because the amount is also too small, the probabilistic forecast should be used with caution. He finished with the outlook for Bhutan which was expected to be above normal. Temperature outlooks for the winter season are more pertinent to the Bhutan context.

Maldives

Dr. Zahid, Maldives Meteorological Services discussed the climatology, weather and climate prediction system, verification of last winter season and prediction for 2016-2017 winter season. He explained about the two major seasons in Maldives, wet season (southwest monsoon extending from mid-May to November) and dry season (northeast monsoon extending from January to March/April). He also explained temperature and rainfall pattern over the year. In terms of observation systems, MMS has one radar, one ocean buoy system, 3 tide gauges, CMA Satellite receiver. The met services run their own NWP (Numerical Weather Prediction) model to generate short range forecast.

He mentioned about the verification system for 2015-16 October to February forecast, pointing out that 2015-2016 temperature was higher than climatology. October to February rainfall is also higher than climatology except for December. Significant anomalies manifested in 2015-16 season as flood, strong wind, rough sea, lightning,

tornado and shortage of water. Overall, his prediction is a below normal condition for rainfall for the Maldives, from Sept-Feb, based on available products.

Myanmar

Ms. Han Swe, Department of Meteorology and Hydrology (DMH), Myanmar explained briefly about the verification system practiced at the department and presented the 2015-16 winter verification process. She explained briefly on general Myanmar climate and winter climate pattern.

Dr. Tin Mar Htay of DMH, presented about current prediction system and prediction for coming winter season. She explained the procedure of 10 days, Monthly and seasonal forecast and operational timelines being followed at DMH. She showed the output of RCC for next winter season ONDJF. She concluded for coming winter season - normal precipitation in the whole country and slightly above normal in Northern Myanmar areas; and normal temperature condition in most of the area.

Nepal

Mr. Shiva from the Department of Hydrology and Meteorology (DHM), Nepal started with the review of 2015/16 Winter Consensus outlook and presented the winter forecast for 2016/17. He like others, introduced a brief climatology of Nepal, forecast for monsoon season, verification process and winter forecast outlook. He pointed out that the winter droughts are becoming more frequent and rainfall condition for 2015-16 winter was drier than normal but winter 2014-15 was above normal. He then, moved on to discuss the prediction for the upcoming season and showed forecast and verification based on the CPT tool. He concluded with the statement that the forecast for post-monsoon rainfall is likely to be normal and winter season is slightly below normal.

India

Dr. S. Balachandran from the India Meteorological Department (IMD)'s Regional Meteorological Centre (RMC), Chennai presented an overview of NEM (North-East Monsoon) 2015 and winter season over India. He explained onset and withdrawal of NE monsoon, and the linkages with Madden Julian Oscillation (MJO), Low Pressure Area (LPA), Depressions and other diagnostics with RADAR products and analysis of winds. He pointed out strong El Niño coupled with warmer SST condition with positive IOD enhance flow over the Arabian Sea. The wind surge in easterlies / north easterlies played role in pumping huge moisture especially to the north coastal districts. Intense rainfall activity generally occurred at the intersection of land and ocean with staggered westward propagation. Temperature distribution of JJA, showed seasonal mean temp: 21.9°C above normal by about 1°C, 3rd highest since 1971 (2006: 22.9°C; 2009: 22.1°C). Both maximum and minimum temperatures were above normal by >1°C over most parts of India except for some isolated places. Monsoon Mission coupled model forecasting system indicates strong probability (90%) of neutral ENSO conditions during NEM season (OND).

He stated that, most global climate models indicate that there is a 57% probability for neutral ENSO and 40% probability for development of weak La Niña condition over the eastern and central equatorial Pacific. SST anomalies over eastern equatorial Pacific (70°W-120°W; 15°S-15°N) and central equatorial Pacific (140°W-170°W; 10°S-10°N) during the month of July were found to be significantly correlated with NEMRT. For the year 2016, area averaged SST anomalies during July over these regions were 0.6°C and 0.12°C respectively which are near normal. He anticipated very little chance of impact of La

Niña on NEM rainfall over Indian region during Oct-Dec 2016. IOD: 70% probability of weak negative IOD conditions during OND 2016.

Finally, he concluded for the 2016 North-east monsoon season (October-December) rainfall over south Peninsula (Tamil Nadu, Coastal Andhra Pradesh, Rayalaseema, Kerala and south interior Karnataka) is most likely to be normal (90 -100% of LPA). The 2016 North-east monsoon season rainfall over Tamil Nadu is most likely to be normal (90-100% of LPA) with a strong tendency to be on the negative side of the normal condition.

Pakistan

Mr. Zubair, representing the Pakistan Meteorological Department (PMD) started his talk on seasonal forecasts by providing a brief overview of the geographical features, meteorological phenomena, and weather systems of Pakistan. He also discussed the existing observation network system of PMD which includes 70 surface observation stations, 12 radiosonde, 88 rain gauge stations, 56 Automatic weather station, 8 river discharge gauges, 2 GLOF station, 1 upper air quality monitoring station and 19 aviation Meteorological centers. PMD has 7 RADARs, NWP facilities and satellite data used. Thereafter, he explained the monthly distribution of rainfall, annual precipitation trends, monsoon system, long range forecasting system, current summer monsoon system, winter rainfall and the outlook for coming winter monsoon season for all provinces of Pakistan.

He concluded with the summary of the prediction for the winter with Precipitation expected to be above normal rainfall is predicted all over the country during the season (September–November) except some extremely northern tips of the country where normal to slightly below normal rainfall is expected during the season. Northern parts of Punjab and adjoining areas of Khyber Pakhtunkhwa are likely to get rainfall with the maximum positive anomaly. Southern parts of Sindh and northern Baluchistan are also expected to get slightly above normal rainfall during the season from September to November.

Sri Lanka

Mr. Mendis from Department of Meteorology, Sri Lanka introduced the climate of Sri Lanka and the criticality of the winter monsoon, as Sri Lanka receives significant rainfall ruing this period (Oct-Nov) and is very important for agricultural and irrigation application perspective. He explained sea surface temperature of last winter monsoon season, rainfall pattern rainfall season and last winter season. He then concluded with the prediction for coming winter season. Precipitation forecast for the winter season is expected to be below normal as suggested by most of the global models.

Summary of climate outlook from the countries

Regional Centre	Precipitation	2m Temperature
Bangladesh	Below normal	Below Normal
Bhutan	Above normal	
Maldives	Below normal	
Myanmar	Normal Rainfall	Above over North; Normal others areas
Nepal	Slightly Below normal rainfall	
India	Below normal to Normal	Normal
Sri Lanka	Below Normal	
Pakistan	Above Normal	

Demo RCC: India Meteorological Department, Pune

Dr. D. S. Pai, Head, Climate Division explained the role of the Demo Regional Climate Centre (RCC), Pune and the evolution and establishment of the National Climate Centre (NCC), Pune in 1995 with an objective to provide various climate related services in India. NCC has been carrying out many India specificclimate related activities like Climate Monitoring and Analysis, Climate Prediction (Seasonal Forecasts), Climate Data Management, and Climate Research.

He also explained background and consensus outlook for last winter season, climatology of South Asia, ENSO and IOD. He pointed out that the current cool neutral ENSO conditions are likely to turn to neutral ENSO conditions and continue till MAM (March, April and May) 2017. He concluded suggesting a normal temperature in BOB (Bay of Bengal), below normal to normal rainfall is likely during Oct-Dec in Southeast peninsular India and Sri Lanka. Remaining region is likely to receive normal Rainfall. During ONDJFM temperature may be normal to slightly above Normal over most parts of the region with some areas in the Northwestern Part of the region likely to experience relatively warmer than normal anomalies.

He then presented the draft consensus outlook prepared for OND period (2016) by collating inputs from the GPCs/RCCs/LC-LRFMME and from the NMHSs of Member countries. He highlighted that precipitation is likely to be below Normal to normal rainfall during the 2016 Northeast monsoon season (October – December) over southern parts of South Asia including southeast peninsular India, Sri Lanka and Maldives. Most of the remaining areas generally receive little amount of rainfall during the season. However, above normal rainfall is likely in some eastern parts of the region, including Bhutan. Other areas of the region are likely to receive normal rainfall. During the season, normal to slightly above normal temperatures are likely, over most parts of the region. The day ended with an open discussion on the consensus forecast by bringing all member countries and expert from RCC and GPCs to provide their feedback and suggestion for the outlook.

Day2: Joint Session of SASCOF-9 and CSUF-Ag

Opening Remarks

The joint session of SASCOF 9 and 2nd Climate Services Users Forum for Agriculture (CSUF-Ag2) on 28th September, 2016 started with the opening remarks by Mr. Aye Ko Ko, Deputy Director General of Department of Agriculture, Myanmar followed by welcome remarks by Dr. Hrin, DG DMH Myanmar and Dr. Rupa Kumar Kolli, WMO. Dr. Srinivasan, Chief Climate Scientist, RIMES welcomed the participants on behalf of RIMES and introduced the agenda for the next two days.

Session 2:

Seasonal Climate information: Enabling Climate Services

Overview presentation on GPCs and Global Frameworks for Climate Services and role of RCCs by Dr. Rupa Kumar Kolli, WMO: He started his talk highlighting the importance of distinguishing between weather and climate for user sectors and importance of providing relevant climate information for decision making in agricultural planning. The next section of presentation provided an overview of WMO Global Producing Centres of Long Range Forecasts (GPCLRFs) and Regional Climate Centres (RCCs) and explanation of their operational arrangements for generating and disseminating forecasts. There are 12 GPCLRFs designated by WMO which routinely provide global-scale LRF products every season. This brings a big challenge as sometimes these forecasts do not agree with each other. For this WMO brings a new initiative "Global Seasonal Climate Update" which will help the RCCs, RCOFs and NMHSs to identify reliable forecast messages from the multiple sources of information. The Climate Services Information System (CSIS), a foundational pillar of the GFCS was introduced which is mostly concerned with the generation and dissemination of climate information. It is considered to be the operational core of the GFCS. It will include climate data, monitoring, prediction (monthly, seasonal, decadal) and projections. For CSIS implementation strategy, there are four components: functional descriptions and products development, operational infrastructure, climate services toolkit and capacity development.

WMO RCCs are centres of excellence that produce regional climate products including long-range forecasts to support the regional and national climate activities and thereby strengthen the capacity of WMO Member countries to deliver better climate services to national users. Some key regional products such as forecasts for major seasons from RCCs are communicated to the national level through RCOFs. RCOFs bring together experts in various fields, at regular intervals, operational climate providers and end users of forecasts in an environment that encourages interaction and collaborative learning.

Currently, the 2nd phase (out of total 3 phases) of GFCS Implementation is in progress, which will end in 2018. This phase is mainly focused on GFCS Operational and Resource Plan (ORP). Various activities as part of ORP are in progress.

General introduction to the drivers of seasonal climate during the winter season of 2015-16, including BoM climate outlook products by Prof Yuriy Kuleshov from BoM (Australia): He presented the general introduction to climate drivers and BoM (Bureau of Meteorology) Climate Services Products. There is a strong link between El Niño Southern

Oscillation (ENSO) and Southern Oscillation Index (SOI) which can provide an indication of the development and intensity of El Niño or La Niña events in many countries. BoM also considers 5VAR Index for El Niño and La Niña events. Sustained positive 5VAR values are indicative of El Niño conditions and sustained negative 5VAR values are indicative of La Niña conditions. The Indian Ocean Dipole (IOD) link with El Niño and La Niña situation and its impact on rainfall and temperature was then explained. BoM uploads various products and also regularly update information on ENSO-SST anomaly, wind anomaly, air temperature, and rainfall. For the summary of a climate model (October 2016 to February 2017), the latest NIÑO3.4 outlooks (initialized in September) show temperatures in the central tropical Pacific are likely to remain cool, but within the ENSO-neutral range for the remaining of 2016. The all-model average NIÑO3.4 outlook for each month between September and the end of this year is between −0.4 °C and −0.6 °C that is still watch level for La Niña.

Extended range products being generated by IITM, Pune by Dr. A.K. Sahai from IITM, India: Dr. Sahai presented the extended range products from IITM, Pune which provides forecast information for 15-20 days. The extended range forecast is part of National Monsoon Mission, project of Government of India and the information is mainly used as a regular update and support for seasonal climate products. Extended range forecast provides clear indications for planning purpose as even in a Normal season there could be some events of above and below normal rainfall and temperature events. For India extended range products are updated every 5 days. Verification of extended range products for the onset of monsoon, monsoon progression across India, monsoon withdrawal and forecast of extremes was then presented. The performance of extended range products was satisfactory all over India and various extreme events for ex. June 2013 (wettest June in last 100 years) and June 2014 (extremely dry) were predicted well. Extended products also capture MJO events, Cyclogenesis, heat waves, extreme rains with good skills. These products are not yet able to capture the onset of North East monsoon as it is very much dependent on withdrawal of SW monsoon.

Use of seasonal climate outlooks for agriculture sector by Mr. Htin Aung Sein from Myanmar: Mr. Htin presented about the Myanmar location, its neighboring countries, agro-ecological zones, land utilization pattern and problems related to weather and climate for agriculture sector of Myanmar. In Myanmar agriculture got the highest priority for climate change adaptation programs. As part of developing adaptation in agriculture various new techniques like AWD, SRI, direct seeding is being practiced in paddy cultivation. Along with these, legume-based cropping system, crop rotation, small-scale water conservation techniques, efficient biomass utilization strategies are also being practiced in Myanmar. Satellite-based drought monitoring is recently started in Myanmar. The major challenges in the country are still the limited knowledge and awareness on the utilization of climate information. Surprisingly, he said that in Myanmar and perhaps in many Asian countries, farming communities and people in general too, still believe more on astrologers then meteorologists!! There is a strong need to enhance awareness and increase advocacy to employ objective approaches to climate risk management.

Sharing the consensus SASCOF-9 climate outlook with users by Dr. Sivananda Pai, IMD, Pune, India: Dr. Pai presented the consensus forecast developed on Day 1 of SASCOF 9. All participants from Meteorological services of South Asian countries agreed on the seasonal forecast for their respective areas of responsibilities.

Highlights: SASCOF 9 Consensus Seasonal Outlook

- South of South Asia will receive normal to below normal rainfall
- West Pakistan, Bhutan, Bangladesh will receive above normal rainfall
- Rest all areas will receive normal rainfall
- Whole South Asia will experience normal to slight above normal temperature

See Annex I for the full version of the consensus forecast issued on 28 September 2016.

Session 3:

Working Group Discussions: Using climate information in the Agricultural Sector – Challenges

After the presentation of the consensus seasonal outlook for the winter 2016-17, focused on October, November and December months Ms. Nina Karla Alparce, RIMES introduced the participants to a set of guide questions formulated to moderate discussions in Working Groups. The participants were divided country wise keeping in view the geographical commonality and the discussions focused on how the provided seasonal outlook can be utilized for planning and in preparedness to risk management in the agricultural sector. Each Working Group consisted of sector representatives and climatologists from the country NMHSs. After about 2 hours of discussions, each Working Group was asked to make a brief presentation summarizing their discussions to answer the guide questions presented.

The points presented by the Working Groups are tabulated below:

Group-1 (Myanmar, Maldives and Bangladesh)

Country	Outlook for Northeast Monsoon(OND)
Myanmar	Rainfall – below Normal in Northern Part Normal over the country Temperature – nearly Normal Above Normal
Maldives	Rainfall – below Normal Central to Northern Part (Normal: 230 mm) Normal Central to Southern Part Temperature – Normal in all area
Bangladesh	Rainfall – above Normal except few places of Central part (40% probability) Temperature – Normal to slightly above Normal Above Normal

Country	Negative impacts on Agriculture
Myanmar	No extreme problems during that period because the crops already standing up in the field. But rice plants need irrigation water Due to nearly Normal rainfall and temperature, there will be no Serious pests and diseases incidence
Maldives	More Salinity intrusion to the land
Bangladesh	Because of above Normal rainfall, transplanted T. Aman may be

	hampered for harvesting during this period Unfavorable for lowland where non-rice crop will be cultivated

Country	Mitigation
Myanmar	Crops with low requirement are substituted in cropping pattern SRI and Direct seeding are practiced in paddy cultivation Medium duration varieties are used
Maldives	Create awareness on efficient use of water/ reduce water wastage Use re-circulatory hydroponics systems for leafy crops: cucumber, Melon etc.
Bangladesh	Cultivate short duration T. Aman rice varieties during this period for early harvesting Also, to suggest timely transplanting of T. Aman rice crop for harvesting in time

Country	Positive impacts on Agriculture
Myanmar	With residual moisture, variety of crop such as pulses, horticultural Crops especially for vegetable can be grown successfully Rainwater harvesting, water saving, and moisture conservation will be carried out for next three months No flood and much inflows so that no damage in hydraulic infrastructures
Maldives	No price deviations in horticulture crops in central to South
Bangladesh	Above Normal rainfall will be beneficial for the high land crops (like Lentil, wheat, potatoes) in the Northern part of the country There is no negative impact on Agriculture due to Normal to slightly Above Normal Temperature Oct- Dec

Country	Recommendation
Myanmar	Farmer awareness through training and extensions Radio, TV, and social media advisories At harvesting field day and farmer meeting at local level Meeting with farmers, government and private for community approach
Maldives	Farmer awareness through training and extensions Radio, TV, and social media advisories At harvesting field day and farmer meeting at local level Meeting with farmers, government and private for community approach
Bangladesh	Exchange of data , agricultural meteorological knowledge sharing between member countries and also an Inter-regional exchange of these materials. Outlook should be specified country wise.

Country	Challenges
Myanmar	Unavailability of grid specific data for the farming islands
Maldives	Using mobile based information, call centers, knowledge center Can directly transfer the message and information to the farmers It prefers Myanmar version
Bangladesh	If the SASCOF outlook does not match with the national forecast, Then the SASCOF outlook will be given less priority

Group- 2 (India, Pakistan & Sri Lanka)

Rain fed Areas	Irrigated Areas	Challenges	Recommendation
1. Above Normal Rainfall: Farmers can go for all crops of the season. 2. Normal Rainfall Areas: - Depending upon summer rainfall and winter outlook, crops may be taken with water conservation methods, short duration varieties and other contingency (supplementary irrigation) 3. Below Normal Rainfall: Prefer short duration & drought tolerant crops. Under worst conditions, go for silage making for livestock to fulfill the fodder deficiency	1. Above Normal Rainfall: Go for all recommended Crops of the season. 2. Normal & Below Normal Rainfall: - Conservation methods may be followed	1. Distribution of Rainfall 2. Management aspects with different/ varieties of farmers.	1. Monthly distribution of rainfall maybe predicted

Group- 3 (Bhutan, Nepal)

Interpretation of Consensus Outlook 2016	Possible Agri. Scenario	Implication on Agri. Sector	Management Strategy
1. The consensus outlook for 2016 for OND predicts Normal rainfall over Nepal and Above Normal Rainfall over Bhutan 2. Whereas the temperature in the region will remain normal or may go	1. Harvesting of Summer crops would be initiated 2. Management of Commercial cash crops would be in place 3. Cultivation of winter crops would be initiated 4. Fodder management for livestock would be	The Agri. Sector in the regions will be affected in following ways: 1. Harvesting of crops world is affected 2.Disease and Pest infestation may occur.	1. Organization / Dissemination of consensus to the possible stakeholders 3. Government to keep contingency/ Cushion fund for adhoc planning and mitigation based on the

slightly above normal.	initiated.	E.g., Armyworms 3. Initiations in cultivation of winter crops would be affected 4. Management of Commercial cash crops would be affected	consensus outlook 4. Dissemination of climate Resilient technologies

Implementation Plan	Challenges on Consensus	Recommendations
1. Organization of NCOFs & Sharing of consensus outlook through media and official correspondence . 2. Use of contingency fund/ Cushion budget 3. Training/ creating awareness among Extension agents, farmers, and policy makers.	1. Climatology - Rainfall over Nepal and Bhutan during OND is very less and rainfall variability is high, so the seasonal forecast be it normal, above normal or below normal doesn't have a significant impact. 2. The threshold for normal, above normal and below normal should be quantified and defined. 3. Need of DJF forecast 4. Ad hoc planning in accordance to consensus outlook would have budget implications	1. Complex topography – need of microclimatic information 2. DJF Forecasting to be initiated 3. Inclusion of Cold wave (fog/ frost)conditions in consensus outlook

Session 4:

SASCOF follow-up at National Level

National level seasonal Forums & agriculture sector user's requirements by Ms. Ruby Rose, RIMES, Thailand: Ruby presented the importance of the flow of information from regional forums (RCOFs) to national forums (NCOFs) and further sub-national levels through various processes like FARM schools. Seasonal forums are sustainable when they are built on the seasonality of climate, tackles information of various timescales and take a multi-hazard approach for multi-sectoral integrated preparedness. Status of Monsoon Forums

conducted by RIMES in various countries was then presented. Myanmar has recently started conducting forums at state and township level. A case study of Sri Lanka was then discussed which presented the success story how Department of Irrigation(DoI) followed the seasonal forecast in Year 2014 and got maximum utilization of available water for irrigation. This lead to arise in crop production even compared to normal years despite 2014 being below normal rainfall in Sri Lanka. Again in 2015, which had above normal rainfall, DoI Sri Lanka could use the forecast to avoid floods in various locations. This indicates that if trust can be built between met department, user sectors and end users forecast could result in realizable benefits.

Subsequent brief presentation by Dr. Srinivasan, RIMES emphasized the importance of creating operational end-to-end systems that are capable of being sustained in various key sectors. He briefed the forum on the WMO GFCS project being implemented by RIMES in South Asian countries supported by Government of Canada funds. One of the main efforts is to create sustained mechanisms to hold National level climate outlook forums and build capacities of both NMHSs and the sector stakeholders. While the NMHSs capacities are required to be built to generate high quality and standard climate monitoring and outlook information, the stakeholder capacities development is focused on enhancing awareness and mainstreaming the delivery of climate information at a continuum of time scales to support various facets of risk management.

Day3: Climate Services User Forum for Agriculture (CSUF-Ag2)

Session 5:

Agriculture Sector's Climate Information Requirements

Dr. Anshul Agarwal, RIMES spoke on maximizing the use of forecast information in Agriculture: Experiences from Farmers Field School in Tamil Nadu, India. Farmer Field School in India was conducted in Nagapattinam, a coastal district in Tamil Nadu, which often experience high-intensity rainfall during the northeast monsoon season, triggered by low-pressure areas, depressions and cyclones from the Bay of Bengal, as well as floods and droughts. All these negatively affect the agriculture production in the area. Major challenges related to climate experienced by farmers in the area include floods, droughts, high incidence of pests and diseases, high water demand due to erratic monsoon season and irregular water supply, and the need for increased agricultural production to satisfy increased requirements for food security. Hence, there is a need to utilize climate information.

From the discussion with farmers on the constraints of using climate information, it was found that the main constraint is the lack of climate knowledge, which should be addressed immediately to be able to overcome all these challenges. Based on consultation with experts, it can be achieved by providing farmers with non-formal education through experiential learning process based on local needs i.e. understanding crop–weather interaction, pre- and post-analysis of climate events in their region; understanding weather forecast information; translating weather and climate information to farm actions; understanding of climate and its relation to pests and diseases, water resources, as well as monsoon onset dates and its implication to their agronomic dates.

The process is called Climate Risk Management Farmers Field School (CRMFFS). Modules of CRMFFS, developed by RIMES, were customized to address the needs of farmers in Nagapattinam district through cooperation with local partners including IMD, Tamil Nadu Department of Agriculture and Centre for Ecology and Research (CER). This process is similar to that of FARM School implemented in Myanmar.

The basic goal of the CRMFFS process is to increase the capacity of farmers to understand weather forecasts and use the same in their regular agricultural operations. The main objective is to employ methodologies to make scientific processes related to weather and climate understandable to farmers and to enhance its utilization in regular farming activities. The CRMFFS has 4 main components delivered through a 12-module training:

i. The Human and Institutional Dimension of Learning Process
ii. Climate Information, Weather and Climate Forecasts
iii. Application of Climate Information and Weather/Climate Forecasts to Farming Operations
iv. Support Programs to Facilitate Broader Adoption.

The process is a multi-tiered process, which starts from the module formulation with the local context. This was achieved through collaboration of RIMES with local partners. This was followed by the Training of Trainers, which was represented by district-level agriculture officers nominated by the Agriculture Department. Then, 5-6 farmers from different villages were selected by the Agriculture Departments, based on potential capacity to train other farmers. The trained farmers then trained other farmers in the succeeding phase.
Dr. Anshul highlighted the various benefits of FFS to the farmers as well as the cost-effectiveness of the process i.e. the investment for this process amounts to about 70 USD per farmer but every farmer who has participated in the process was able to save, on average, 41 USD/year/acre of land. There was also a horizontal diffusion of knowledge/learning as the 15 farmers trained another 120 farmers. Various indirect benefits were also experienced i.e. reduced energy consumption as pumping is reduced due to more efficient irrigation and reduced utilization of pesticides, which has a positive impact on the environment. One challenge found during the process is the provision of forecast information to the farmers on a daily basis. To address this, an agro-advisory system was developed by RIMES in collaboration with Tamil Nadu State Planning Commission and the Agriculture Department. The interface developed provides 3-days and 10-days forecast from IMD and various other sources.

Q&A + discussions:

<u>If the forecast goes wrong, how will you help the farmers?</u> The nature of the FFS process does not involve imposing actions on the farmers but rather just enabling them to integrate climate information and forecast into their cropping pattern and activities in realizing the options available for them. The farmers are encouraged to take their own decisions informed by climate information and forecasts. The information provided to them are probabilistic and the uncertainty is properly communicated to them. Hence, it is up to the farmers to decide which option would be most beneficial for them.
<u>(Follow-up) In that case, weather has more effect on crops (than climate)</u>: Actually, the process initiates utilization of all kinds of forecasts, of various timescales – seasonal forecast to decide which crop or crop variety to plant during the season, 10-days forecast to decide about activities such as irrigation scheduling, pesticide application, and 3-days forecast for other farm decisions and activities.

How to communicate information to the farmers? All trained farmers are already associated with the Trainers from the regional district Agriculture Department. So, the Agriculture Officers-Trainers receive IMD forecasts, which they communicate to the farmers, via SMS and email, along with farming operation guidelines (translated to local language) that they have formulated based on the forecast. The trained farmers, in turn, share the forecast and advisory/guidelines to other farmers especially those without access to internet/email and mobile services.
Do farmers, as presented, make all the decisions based on seasonal forecasts? What climatologists need to understand is that users, particularly farmers, don't distinguish the information provided by NMHSs as weather or climate information, but rather as a continuum of information at different scales. So they make various decisions based on a full range of information, seasonal and sub-seasonal information that serves as updates. This is the case for all sectors, not just agriculture, but also water sector and many others.

Country Presentations

Bangladesh

Dr. Abul Basar Md Zahid Hossain: Bangladesh experiences and is vulnerable to various hazards that affect agriculture production such as cyclones, floods, and sometimes heat and cold waves. Cereal production has increased from about 10 million tons in the 1970s to more than 34.7 million tons in 2014-15 with fluctuations often due to natural disasters. Since the country's independence, it has suffered from different magnitudes of drought. Meanwhile, cultivated lands in coastal areas have been affected by salinity. Hence farmers need to adapt using quick growing crops (e.g. short-duration paddy), appropriate cropping pattern (e.g. alternative intercropping approach), and new adaptive technologies.

Agricultural production in Bangladesh is divided into 3 cropping seasons based on climate: (1) dry season crops, (2) pre-monsoon crops, and (3) rainy season crops. He presented the climate change impacts in the agriculture sector of Bangladesh as follows:

- Summers are becoming hotter
- Monsoon has become more irregular, characterized by untimely rainfall
- Increased river flow and inundation during monsoon
- Heavy rainfall over a short period of time resulting in water logging
- Increased frequency, intensity and recurrence of flood
- Heavy rains and the onrush water from the hills have triggered a flash flood during pre-monsoon season. Crop damage due to flood, drought, prolonged cold spell, and pest and disease incidence has also increased.

Agro-advisories are provided to farmers mainly by DAE (Department of Agricultural Extension) and NARS (National Agricultural Research Systems) to avert risks and to cope with climate change more effectively. This helps in identifying integrated adaptation and mitigation options for a range of agro-ecosystems.

Bhutan

Mr. Sagar Acharya: About 69% of Bhutan's population is dependent on agriculture. The Department of Agriculture is currently developing crop suitability map for various important crops including Maize, Potato, Vegetables, Large Cardamom, and Quinoa,

among others supported by the World Bank. This involves utilization of climate data and GIS and thus the department faces the following challenges

- Poor access to climate data and lack of utilization of climate data in agricultural research;
- Data is not in the usable form i.e. they need climate data in shape form which can be easily assimilated in GIS applications

Other challenges/gaps in the sector/department include:

- Most agricultural researchers are focused on achieving the national food security goals without a clear understanding of climate change risks and use of climate data.
- Lack of technical capacity of agriculture researchers to take up adaptation and evaluation of climate resilient technologies
- Limited technical capacity on climate science research approaches and tools (both within and outside the department)
- No studies that explicitly evaluate the impact of climate or climate change on crops and farming system are done
- Bio-physical sensitivity and vulnerability status of regions and Dzongkhags to the impact of Climate Change are not adequately studied
- Many climate change induced impacts on agriculture such outbreak of new pests, crop failures and climate-related disasters are addressed on ad-hoc basis with a knee-jerk approach e.g., Rice blast outbreak, GLS outbreak in maize, Armyworm outbreak
- Climate change is an emerging issue and needs to be appropriately and adequately mainstreamed into the national commodity programs
- Currently, DoA is exploring opportunities and options to facilitate the use of climate data in agriculture through few existing projects like Climate Change Adaptation Programs (CCAP), funded by EU-GCCA, and NAPA. DoA is planning to incorporate the use of meteorological data in all the crop insurance schemes/programs.
- Bhutan with its rugged terrain and fragile environment the effect of climate change can be felt heavy, hence, the development and implementation of climate resilient agricultural technologies are necessary. The department would like to use high-quality data in every possible way to improve and develop the agriculture sector in Bhutan. The impact of climate change striking like a quake, Bhutan is keen to safeguard its backbone i.e., agriculture till its last breath.

Q&A + discussions:

How does Bhutan control pests and diseases in an organic system? Right now, Bhutan has a semi-organic system due to the limited availability of chemicals. They prepare organic and bio-pesticides (from plants, grasses) and employ other biological methods for crop protection.

Maldives

Dr. Shafia Aminath: The agriculture sector contributes around 2.1% to the GDP of Maldives and provides employment to around 3% of the country's labor force. Agriculture and Fisheries are the main sources of rural livelihood. Diversity in agricultural production has been initiated to reduce vulnerabilities in livelihood as well as food/nutrition security, i.e. growing horticultural crops such as coconut, banana, breadfruit, papayas, watermelon, mangoes, taro, chilies, sweet potatoes, eggplant, pumpkin, passion fruit and others as well as poultry and small animal production were encouraged. Value added products such as toddy sugar, taro &bread fruit chips, chili pastes, virgin coconut oil, etc. are produced at a small scale. One of the agriculture management policies aims to increase production and product diversification to reduce reliance on imported food and thus attain self-sufficiency in terms of selected crops through Island-level crop specialization. For enhancing employment & income opportunities in the sector with a special focus on youth employment, new technologies and improved training and extension and market information systems are to be introduced.

Crops loss and damage due to climate-related hazards including flood due to heavy and intense rainfall, high wind velocity, pest and disease outbreaks, salt water intrusion in the coastal area & water shortage and transportation of food during adverse weather for food security, among others, have increased over the years. Hence, climate information use is necessary for policy formulation and planning i.e. for climate insurance, premium payment must be based on climate information. The gaps and needs in climate information utilization in the sector include:

- Climate data is not used at sub-national /island level. Farmers require localized and accurate data and more indicators such as soil and water salinity, information on humidity, temperature, and pest damage.
- Moreover, farmers do not understand the importance of climate data. This requires training and extension and process such the farmer field school to introduce information on climate/weather variables
- Need for small pilot projects so that the farmers will understand and appreciate the importance of climate information
- Need to introduce early warning advisories on climate forecast

Myanmar

Mr. Htin Aung Shein: Climate information and services needed in Myanmar:

- Preparation of cropping calendar for every farmers and extension workers from farm school experience
- Strengthening the role of agro-meteorologists in the food security sector of the country.
- Enhancing the collaboration between DMH and DOA (in integrating weather and climate information in crop production) through the farmers' channel (TV).
- Weather and climate forecasts for preparing the action plan before crop production
- Climate data for selection of appropriate crops in the different states and regions and for the adoption of new agricultural

technologies to improve the sustainable agriculture programmes.
- Climate change risk education to primary, middle, and high school

Nepal

Ms. Asha Sharma: Agriculture contributes one-third to GDP of Nepal. About 21% of Nepal's land is cultivable, 57% of which is rain-fed area. Average land holding is 0.68 ha. Major crops in the country are Paddy, Maize, Wheat and Horticultural crops. Livestock grown in the country are primarily cattle, buffaloes, sheep/goat, pigs and poultry. Climate conditions in Nepal are strongly influenced by the monsoon circulation. The main source of rainfall is the summer monsoon season, which brings more than 80% of annual rainfall. The average monsoon duration is 120 days and mean annual rainfall is 1530 mm. The driest month is November while wettest month is July.

Major challenges in the agriculture sector include pests and diseases, fire, flood and market price fluctuations. Climate-related hazard events in the country cause severe threats to agricultural sector and thereby to food and nutrition security, lives, property, and livelihoods. These include drought, floods, landslides, windstorms, hailstorms, and heat wave/cold wave. Both too much and too little water due to abnormal rainfall distribution in the country has devastating impacts in the agriculture sector. There are various existing interventions and Climate-Smart Agriculture (CSA) Practices in the country. There are also water-smart, weather-smart, carbon-smart, nutrient-smart, knowledge-smart, and GESI-smart practices in agriculture.

Currently, Nepal has an Agriculture Management Information System (AMIS), which is an integrated information system developed through the collaboration among the meteorological (DHM), agricultural research (NARC) & agricultural planning and extension (MoAD) institutions to provide relevant weather & climate information to farmers in Nepal. This provides a mechanism to deliver relevant climate and weather information and agriculture decision support tools to farmers on a timely manner. The MoAD-managed AMIS will help bridge the gap between DHM and the farming communities by creating weather and climate products that cater to the specific needs of the farming community. An extensive network of national, sub-national and local government agriculture offices and farmer groups will also help in disseminating the information. The current challenges of agriculture sector are:

- Monsoon dependent agriculture system
- Unavailability of weather forecast (Weekly, Monthly, seasonal, Annual)
- Natural hazards such as floods, landslides, cold weather, drought and earthquakes.

MoAD is committed to work in collaboration with INGOs, the private sector, and other development partners for addressing the challenges brought about by climatic variability to achieve the vision and national goal of food and nutrition security and improved livelihoods in Nepal.

India

Dr. AVM Subba Rao: Rain-fed agriculture solely depends on monsoon rains and sowing times vary based on a forecast of soaking rains. Timely planting alone contributes to 25-

30 percent higher yield in rain-fed crops. Sub-seasonal forecasts of dry spells help farmers undertake drought management operations and withhold use of inputs and in irrigated areas need as follow:

- Long range forecast of low rainfall helps farmers in avoiding crops with high water demand (e.g. rice)
- High resolution (block or village) forecast helps farmers on timing of irrigation and saving on fuel, labour and ground water
- A robust weather based pest/disease forewarning helps farmers to avoid spraying, saving on cost and environmental pollution.
- Early, mid and late drought situations to be expected during Monsoon season. The frequency of extreme weather events, such as either excessive or deficient rainfall and unfavorable conditions for normal plant growth causing damages to crops may increase due to climate change.
- Application of forecasts of various timescales in agriculture:
    - Short range forecast (up to 3 days) is useful for sowing, irrigation and pest management.
    - Medium range forecast (3 –10 days) is more useful for above operations in having more lead time, better decision making and efficient resource use (labour, inputs).
    - Extended range forecast (10 to 30 days) is useful for contingency plans as more lead time is available.
    - Seasonal/Long range forecast is useful for crop selection and input management. ICAR and the parliamentary standing committee on agriculture, recommended preparation of district- level contingency plans for weather extremes.

The Ministry of Agriculture, Government of India assigned these issues listed above as a responsibility of Indian Council for Agricultural Research (ICAR), which then prepared and finalized templates for contingency planning in consultation with DAC&FW (Department of Agriculture, Cooperation and Farmers Welfare). The Secretary of Agriculture approved the proposal and instructed all the relief commissioners to cooperate with State Agricultural Universities' (SAUs). The approach is bottom-up, involving district level scientists of Agricultural Research Stations and Krishi Vigyan Kendhra's (KVK's) [or Agricultural Science Centres] of SAUs and the 46 SAUs and 8 ICAR institutes. The District Agricultural Contingency Plans mainly contain the district agriculture profile, major hazards experienced, and the weather-related contingency table, among others. Contingency measures/plans for 5 key crops/horticulture crops at nursery, vegetative, flowering, maturity, post-harvest stages are prepared.

Advisories for farmers should provide more emphasis on resource management to mitigate impacts of weather aberrations and drought contingency measures in villages/mandalas, which are drought prone. Multi-crop models (Navadhanya model) are being encouraged in low to medium rainfall zones. Regular videoconference meetings to be held with district authorities on updated weather forecast. The activities of NICRA (National Innovations in Climate Resilient Agriculture), integrate farming system and Livestock interventions.

Pakistan

Dr. Tasneem Khaliq: The total land area of Pakistan is 79.6 M ha, 23.8 M ha of which is cultivated, contributing about 20% to GDP and providing employment to around 45% of the country's labor force. The majority of the rural population depends upon this sector for its livelihood. Pakistan has a total of 26 agriculture universities. The climatic classification of Pakistan includes arid, semiarid, sub humid and humid categories. Approximately 2/3 of the area of Pakistan lies under arid climate.

June is the hottest month (48°C) in the plains and July in the mountainous areas, with temperatures over 38°C.The mean monthly minimum temperature is only 4°C in December/January. Average annual precipitation is estimated at 494 mm. Maximum rainfall is 1500 mm in the north. Most of the rainfall in Pakistan originates from summer monsoons.

Major crops in Pakistan include maize, sugarcane, rice, cotton and wheat. The agriculture problems/challenges in Pakistan include: limited cultivable area, low yield per unit area, conventional methods of production, lack of high-efficiency irrigation facilities, inadequate supply of agricultural inputs, decreasing the availability of water, and lack of R&D and Decision Support System for site-specific production technology. Pakistan Meteorological Department (PMD) provide following services related to climate that include drought monitoring and warning services, Crop reports and the Seasonal outlook for Pakistan. In a study five General Circulation Models (GCMs) have been used to generate future climate change projections. Two crop models (DSSAT and APSIM) were used to simulate yield and to assess climate change impact. Economic model (TOA-MD) was used to quantify the climate vulnerabilities and adaptabilities.

Better collaboration of PMD with Agriculture department is necessary. There is also a need to build the capacity of stakeholders in better understanding the forecasts and contingency crop production plans in collaboration with PMD.

Session 6:

Use of operational climate information for agricultural risk management

Ms. May Khin Chaw, DMH presented DMH strategies for Agro-met development in Myanmar and Existing Agro-Met services. Currently, DMH has 17 agro-met stations in which weather parameter observations are done 5 times per day. The Agro-Met Division issues an agro-met bulletin every 10 days, containing information on temperature, rainfall and rainy days, humidity, soil water balance and potential evapotranspiration of last 10 day and forecast for next 10 day. Agro-met Weekly Forecasts are also issued and broadcasted in TV Farmer Channel since 2013 September. The Agro-met Weekly and 15-days forecast are issued in some agriculture journal by the request. Crop Weather Calendar has also been prepared for some crops like rice, cotton, jute, sugarcane etc. These calendars are very useful tools for agriculture i.e. in assisting agricultural planner, decision makers in their endeavors. This is available in the Agro-meteorological section of www.moezala.gov.mm. Other agro-meteorological information is also available in DMH's Facebook page.

Initiatives to enhance the agro-met services of DMH

- RIMES has been providing assistance to DMH and the Ministry of Agriculture and Irrigation (MOAI) in implementing key recommendations of the 9th Monsoon Forum in Nay Pyi Taw in October 2012, in particular the development of tools to support users of weather and climate information:
- An updated agro-ecological zone map for Myanmar
- Crop-weather calendars that take into consideration the climate pattern in the past decades
- An Expert system (http://agro.rimes.int/myanmar) for translating weather and climate information into potential impacts and management options. It generates and disseminates agro-met bulletins based on short and medium range weather and climatic parameters. It was customized for two pilot sites of Dry Zone in Myanmar i.e. Nyaung Oo and Monywa. It is built on two weather model input datasets: (1) ECMWF Deterministic Forecast with 10 days lead time and (2) WRF Model data from RIMES with 3 days lead time. It is capable of ingesting these two datasets and generates 10 days or decadal Agro-Met bulletins (disseminated by email and fax) and 3 days short-term forecasts (disseminated by SMS message).
- Climate Risk Management Field Schools (FARM School) to introduce farmers to the use of science-based information in decision-making has been customized and piloted in Nyuang Oo and Monywa
- Upgrading of the country's agro-meteorological network - 17 agro-met AWS stations.
- In World Bank's Hydro-Met Observation and Information Systems Modernization Project, one of the components entails Enhancement of Hydromet Delivery Systems through Development of an Agricultural and Climate Advisory Service.

Further needs include Training on GIS application and remote sensing, agro-ecological zoning, satellite-based data communication, crop modeling and crop simulation software and other relevant software. Priority needs are for Training in agro-meteorological courses i.e. Master's and Doctoral programs, expansion of FARM School, awareness building of extension workers to understand weather forecasting outputs and agricultural advisories so that they can communicate the same effectively to farmers. Information demand from user sectors include climate information to livestock herders, the main interests include extreme heat related to heat stress in livestock and flooding in order to move cattle in time. Hence, severe weather warnings are most relevant. Farmers also need information about monsoon onset, amount of rainfall, number of rainy days in the 10 day period (and its impact on the use of labor, daily schedule, fertilizer application, planting, etc.), extreme temperatures and other severe weather warnings. For the fishing communities, main interests are on severe weather and personal safety related to flooding and river/lake conditions.

Future actions plans include:

- Making better use of existing information
    - Ensuring that the wide ranges of existing products are widely disseminated using a wide range of channels, particularly Facebook (DMH, MOALI)

- Exploring the feasibility of the development of additional mobile apps for specific target users (RIMES, FAO)
- A joint project on the development of crop calendars and understanding links between weather and crops at the district/township level (DMH, MOALI)
- A joint project on heavy rainfall and the development of national datasets, guidelines etc. (DMH, MOALI – although probably under the DRR components in AIRBM rather than ACAS).
- Explore improving application of ECMWF data – also potential use of Met Office global MOGREPS 14 day forecasts in existing RIMES project.

- Building capacity at all levels
  - Inclusion of agro-meteorology training at DMH and MOALI (FAO, CCAFS, DAR, Yezin University)
  - Farm extension workers and township committees
  - Farm schools

- Making use of improved operational forecasting products
  - Including agro-meteorological objectives in systems design under World Bank System Integrator work (AIRBM C2)
  - Improve the observation network (AIRBM C2) including development of existing MOALI observation networks and consideration of low-cost observation stations.
  - Improve numerical weather prediction (AIRBM C2)
  - Improve seasonal forecasting (Monsoon Forum)

SASCOF & CSUF-Ag website hosted by RIMES

Mr. Itesh Dash, RIMES made a brief presentation on how the SASCOF and CSUF-Ag websites have been created and hosted by RIMES for the last two winter SASCOF Sessions. After the presentations, the consolidation of all presentations and forum resources for all SASCOF events into one web resource was suggested.

Panel Discussion: Opportunities and challenges – road map for better use of climate services for the agricultural sector

Panel Members: Dr. Hrin Nei Thiam DG, DMH, Myanmar, Dr. Kolli, WMO and Ms. Khon Ra, Director, Department of Irrigation (DOI), Myanmar, Moderator: Dr. Srinivasan, Chief Scientist, Climate Applications, RIMES

The panelists were requested for their views on the topic of "Opportunities and challenges - road map for better use of climate services for the agricultural sector" focusing on the following -

1. Important aspects of the climate information that need to be provided at a national level to facilitate crop yield estimation and planning for food security.
2. How should this information be provided to make a difference in the decision-making process?

3. Recognizing that a lot of project initiatives are being taken up, how do we go about operationalizing such efforts?
4. To make the SASCOF and CSUF-Ag a more systematic process that can be sustained through collaboration or leadership within the NMHSs or agricultural sector agencies from within the region.

Dr. Hrin Nei Thiam, DG, DMH: DMH has conducted the Monsoon Forum since 2007 with the support of RIMES and UNESCAP. Through these monsoon forums, DMH was able to interact with their users like the agriculture, water resources, and health sectors among others. There were many recommendations raised during the forums such as: A. Dissemination of DMH forecast products through Facebook to reach more users; B. Inclusion of the expected number of rainy days in the forecast - a recommendation from Agriculture sector which has been implemented in the 10-day and monthly forecast C. Dissemination of DMH forecast products through the Farmer Channel

There is also a need expressed by users for provision of localized/area-specific forecasts. DMH is however, currently providing only region- or state-wise and city forecasts. Users also require forecast information on rainfall quantity but DMH needs to build capacity on this. There are current projects through which they are trying to obtain the technology and capacity for generating such information.

FARM School in Dry Zone piloted in Nyaung Oo and Monywa – familiarized farmers in concepts of weather and climate, and enabled a better understanding of forecasts. The project also enabled DMH to provide forecasts to the pilot areas but they need feedback from the farmers and users to better understand how farmers can better understand and use forecasts.

In 2015 and 2016, Myanmar has experienced several hazard events. In 2015, a countrywide flood event occurred affecting 12 regions/state. In 2016, with the El Niño event, hazards experienced include extreme temperatures, drought, and a decline in groundwater level causing scarcity of water in many areas that prompted the government to distribute water. Hail also occurred, bigger than previous events, which caused a lot of damage to the agriculture sector. The event further highlighted the need for more accurate and localized forecast.

Dr. Hrin commented that the SASCOF-9 and CSUF-Ag 2 was very helpful and they will use it as a reference in the coming national monsoon forum.

Ms. Khon Ra, Director, DOI: DOI has been participating in the national Monsoon Forums and has received seasonal outlooks, which they share and use in planning for the coming season. The climate-smart agriculture technologies project of Nepal is interesting. Some climate-smart agriculture projects are being initiated in Myanmar following FAO approach. Climate information is particularly required in the implementation of some recent projects taken up by DOI like the Climate value chain project (from 2016 up to the next 5 years) and the National Comprehensive Development Plan – that includes many projects/plans for the agriculture sector.

For DoI's water resources project's – besides seasonal outlooks, shorter-range forecasts including information on rainfall intensity are also required. In 2015, flooding in reservoirs was very challenging; there were cases of overtopping of the reservoir walls. Hence, efforts are to install rain gauge networks in the upper catchments as well as within the catchments. However, due to limited resources, installation of rain gauge stations will be

limited to only a few areas. She requested DMH, RIMES and WMO to provide advice on the management of fields, prevention of flood, and dam safety. She also requested other participant countries to share knowledge on how they receive early warning relevant to dam safety and use emerging technologies (e.g. satellite) to manage flood risks.

Dr. Rupakumar Kolli, WMO: Dr. Kolli emphasized the fact that the SASCOF process has been going on in South Asia since 2010 and that it is now time for countries from the region to start thinking about creating a mechanism for sustaining it through regional contribution and leadership. He also mentioned the need for documentation of experiences i.e. Monsoon Forums highlighting the gaps and needs/requirements as actual action is at the national level. This can be done with the help of RIMES and other regional centers. He also recommended that climate information should align to new development projects and use of climate information must be enhanced amongst national level users.

Other intervention from Bangladesh, Nepal, Bhutan and Maldives suggested

- Research on updating climate models and develop over all agro-meteorological capacity in the region
- Enhance agrometeorological knowledge among member countries and increase inter-country interaction;
- Difficulties in having the same person attending the forums because of the regular change in staffing in their departments
- Suggests provision of presentation guideline to the participants from the agriculture sector to ensure that they will be able to provide the necessary information during the forum
- Set a special session in the forum for identifying gaps and having Agri. Sector participants in the sessions for the GPCs and RCCs presentation so that they would have a better understanding of what's happening in the region
- Suggestions for having more time for discussions in working groups

Recommendations

The following recommendations were summarized based on discussions at the forums:

- Dissemination of outlooks and other forecast products through innovative approaches including popular social media platforms to reach more users sector communities; continuing to disseminate information through established channels like TV (e.g. Farmer's weather channel) with efforts to enhance user-oriented climate information content
- The inclusion of parameters like onset dates of the rainy season, expected number of rainy days in the forecast, temperatures and climatology presented in terms of tercile categories being used in the outlook so that it will be straightforward to convert, are considered very useful by the Agriculture sector. Efforts to provide localized/area-specific forecasts need to be also taken up based in conjunction with a good understanding of the

specific user context. Alignment of the climate information being provided to new national development projects is also required to maintain relevance to current and specific needs of the user sectors.

- Seasonal outlooks information should be updated with monthly and extended range predictions and used in combination with a medium and short-range forecast for risk management in agriculture and irrigation sectors. Common regional climate data bases need to created to both improve climate predictions and to build confidence in their performance.
- User sector feedbacks are very important and they must form a key component of the whole process of improving climate services. There is also a need for proper documentation of the regional and national level experiences with various stakeholders that are ongoing.
- Capacity development of NMHSs needs to be focused on enhancing their abilities to deliver these weather and climate products to ultimately provide better climate services. Having nominated focal points in NMHSs and key user sector departments like agriculture will enable sustained development of such capacities through trainings and providing access to all relevant information, data and products to be made available for the region.

Annex 1. Name of the Participants

Sr. No.	*Name of the participant*	*Designation*	Organization
SOUTH ASIAN CLIMATE OUTLOOK FORUM (SASCOF-9)			
1	Mr. Murukuwadura Meril Prasantha Mendis	Meteorologist in Charge	Department of Meteorology Ministry of Disaster Management 383 Bauddhaloka Mawatha Colombo 07, Sri Lanka
2	Ms. Nayma Baten	Meteorologist	Climate Division Bangladesh Meteorological Department (BMD) Abhawa, Agargon Dhaka 1207, Bangladesh
3	Dr. S. Balachandran	Scientist 'E'	Cyclone Warning Research Centre Regional Meteorological Centre 6, College Road, NUMGAMBAKKAM Chennai, India
4	Mr. Shiva Prasad Nepal	Senior Divisional Meteorologist	Department of Hydrology and Meteorology (DHM) Kathmandu, Naxal Nepal
5	Mr. Tayba Buddha Tamang	Senior Meteorologist	Department of Hydro Meteorological Services (DHMS) Ministry of Economic Affairs Royal Government of Bhutan P.O. Box 207 Thimphu, Bhutan
6	Mr. Zahid	Deputy Director General Climatology	Maldives Meteorological Service Hulhule 22000 Maldives
7	Mr. Zubair Ahamad Siddiqui	Director of Regional Meteorology Centre	Pakistan Meteorological Department (PMD) Headquarter Office Sector H-8/2 P.O. Box 1214 Islamabad, Pakistan
CLIMATE SERVICES USERS FORUM FOR AGRICULTURE (CSUF-AG2)			
1	Dr. A.V.M. Subba Rao	Senior Scientist	Central Research Institute for Dryland Agriculture
2	Dr. Abul Basar Md Zahid Hossain	Senior Scientific Officer	Irrigation and Water Management Division
3	Dr. Aminath Shafia	Director General	Ministry of Fisheries and Agriculture MALE, Maldives
4	Ms. Asha Sharma	Agri-Economist	Ministry of Agriculture Development Singhadurbar Kathmandu, Nepal
5	Mr. Sagar Acharya	Agriculture Officer	Agriculture Research and Extension Department of Agriculture Ministry of Agriculture and Forests Thimphu, Bhutan
6	Dr. Tasneem Khaliq	Assistant Professor	University of Agriculture, Faisalabad University Road Faisalabad, Pakistan

	RESOURCE PERSON AND DONOR		
1	Mr. Andrew William Colman	Senior Climate Scientist	Met Office Hadley Centre Fritzroy Road Exeter Ex8 4NS United Kingdom
2	Dr. Atul Kumar Sahai	Scientist G	Climate Prediction Department Indian Institute of Tropical Meteorology (IITM) Dr. HomiBhabha Road, Pashan, Pune 411 008 Maharashtra, India
3	Dr. Changzheng Liu	Senior Forecaster	Beijing Climate Center China Meteorological Administration (CMA) 46 Zhongguancun Nandajie 100081 Beijing, China
4	Ms. Gayoung Kim	Researcher	Korea Meteorological Administration (KMA) WMO LC-LRFMME 61 16-Gil Yeouldaebang- Ro Dongjak-Gu Seoul 07062, Republic of Korea
5	Dr. Rupakumar Kolli	Chief	World Climate Application and Service Climate Prediction and Adaptation World Meteorological Organization Secretariat 7 bis, Avenue de la Paix Case postale 2300 CH1211, Geneve 2 Switzerland
6	Mr. S.H. Kariyawasam	Former Director General	P.O. Box 383, Bauddhaloka Mawatha Colombo 07, Sri Lanka
7	Mr. Shoji Hirahara	Scientific Officer	Tokyo Climate Center (TCC) Japan Meteorological Agency (JMA) 1-3-4, Otemachi, Chiyoda-ku Tokyo, Japan
8	Dr. Sivananda Pai Damodara	DDGM	Climate Service Division Indian Meteorological Department (IMD) Shivajinagar Pune 411005 India
9	Dr. Yuriy Kuleshov	Professor	Bureau of Meteorology 700 Collins Street, Docklands 3008, Melbourne Australia
	DEPARTMENT OF METEOROLOGY AND HYDROLOGY (DMH), MYANMAR		
1	Dr. Hrin Nei Thiam	Director General	Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
2	Ms. Ye YeNyein	Director	Yangon Department of Meteorology and Hydrology

			Nay Pyi Taw, Myanmar
3	Ms. Khin Cho Cho Shein	Director	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanma
4	Ms. Tin Yi	Director	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
5	Ms. May Khin Chaw	Deputy Director	Yangon Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
6	Mr. Hla Tun	Deputy Director	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
7	Mr. Tin Htut	Deputy Director	Yangon Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
8	Ms. NyeinNyeinNaing	Deputy Director	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
9	Mr. Win Maw	Assistant Director	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
10	Dr. Than Naing	Staff Officer	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
11	Ms. Han Swe	Staff Officer	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
12	Dr. Tin Mar Htay	Staff Officer	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanma
13	Ms. Aye Aye Soe	Staff Officer	Yangon Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
14	Ms. Chaw Su Hlaing	Deputy Superintendent	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
15	Dr. Khin Thin Yu	Deputy Superintendent	Yangon Department of Meteorology and Hydrology

			Nay Pyi Taw, Myanmar
16	Ms. Shwe Ye New	Staff Officer	Yangon Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
17	Ms. ThazinPhoo	Staff Officer	Nay Pyi Taw Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar
	REGIONAL INTEGRATED MULTI-HAZARD EARLY WARNING SYSTEM FOR AFRICA AND ASIA (RIMES)		
1	Mr. A. R. Subbiah	Director	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120
2	Dr. Govindarajalu Srinivasan	Chief Scientist	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120
3	Ms. Ruby Rose Policarpio	Institution Development Specialist	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120
4	Dr. Anshul Agarwal	Hydrologist	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120
5	Mr. Itesh Dash	Team Leader, System Research and Development	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120
6	Ms. Nina Karla Alparce	Program Officer, Societal Application	Regional Integrated Multi-Hazard Early Warning System (RIMES) 2nd Floor, Outreach Building Asian Institute of Technology Campus Klong Nung, Klong Luang Pathumthani 12120