Regional Workshop on Climate Services at the National Level for the Least Developed Countries in Asia

Bangkok, Thailand,
8-10 October 2012

FINAL REPORT

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1. Introduction

1.1 The World Climate Conference - 3 held in 2009 decided to establish a Global Framework for Climate Services (GFCS), an international framework to guide the development of climate services. The vision of the GFCS is to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to such risks. This will be done through development and incorporation of science-based climate information and prediction into planning, policy and practice. The greatest value of the GFCS will occur incrementally through the delivery of a multitude of climate services at national or local levels.

1.2 The High Level Taskforce (HLT), constituted to further develop the GFCS concept and scope out the next steps in its implementation, enumerated eight principles to ensure that the GFCS provides the greatest benefit to those who need climate services the most. Principle 1 emphasizes that all countries will benefit from GFCS, but priority shall go to building the capacity of climate-vulnerable developing countries.

1.3 The HLT recommended that by the end of 2017, access to improved climate services should be facilitated globally in four priority sectors (agriculture, disaster risk reduction, health and water). Climate information will normally be tailored to suit a range of purposes – from advice to political leadership through guidance to government administrators, to support for the wide diversity of community interests, including industry and commerce. The process will typically involve the translation of temporal and spatial information about the climate into decision support tools to suit the needs of specific sector applications, with the means of carrying out the translation underpinned by applied climate research that targets each climate sensitive sector.

1.4 Climate-sensitive developing countries stand to gain the most from better climate information but are often precisely where climate services are weakest. The Framework will give priority to capacity building in these countries.

1.5 It is with this background that the World Meteorological Organization (WMO), the Asian Development Bank (ADB) and the Food and Agriculture Organization (FAO) organized the Regional Workshop on Climate Services at the National Level for the Least Developed Countries (LDCs) in Asia from 8-10 October 2012 in Bangkok, Thailand.

1.6 Fifty one experts participated in the workshop (Annex I) including participants from 9 LDCs in Asia i.e., Bangladesh, Bhutan, Cambodia, Lao P.D.R, Maldives, Myanmar, Nepal, Samoa and Vanuatu as well as Asian Development Bank, Asian Disaster Preparedness Centre, CGIAR Climate Change, Agriculture, and Food Security (CCAFS) Project, Food and Agriculture Organization (FAO), International Federation of Red Cross and Red Crescent Societies (IFRC), Regional Integrated Multi-Hazard Early Warning System, UNOPS, World Health Organization (WHO), World Meteorological Organization (WMO), Thai Carbon Fund, USAID and Thailand participated in the workshop.

1.7 The workshop was organized in twelve sessions (including opening and closing sessions) covering different aspects such as LDCs and Climate Services; Current Status of Climate Services in the LDCs of Asia; Needs for Climate Services in the Agriculture, Water, Health and Disaster Risk Reduction Sectors; Climate Risk Management; and Building and Operating

Climate Services at the National Level. Detailed programme for the workshop is shown in Annex II.

2. Opening of the Workshop

2.1 Dr Somchai Baimoung, Acting Director-General, Thai Meteorological Department (TMD) welcomed all the participants at the workshop on behalf of the Government of Thailand. He mentioned that, in terms of climate service, climate information and prediction products are essential not only to support the general human activities and socio-economic sectors but also to assist in the planning and making of decisions of the concerned governmental agencies for natural disaster mitigation and preparedness. He informed the meeting that TMD has been making the efforts to develop our climate prediction and information service for the maximum benefit of users, and seeking new technologies, and capacity building of operational staff to increase their services to achieve the expected goal. He wished the workshop all the success.

2.2 On behalf of Mr Michel Jarraud, Secretary-General of WMO, Mr Filipe Lucio, Head of the GFCS Office in WMO welcomed all the participants to the workshop. He thanked TMD for agreeing to host the workshop in Bangkok and ADB and FAO for co-sponsoring the workshop. Mr Lucio mentioned that a growing number of countries are establishing capabilities for offering climate services. They are building on their experiences in providing weather and climate information to create customized services targeting specific users. In this way, climate services make it possible to incorporate science-based climate information and prediction into planning and policy to achieve real benefits for society. This is needed because the challenges facing humanity today are increasingly complex, interconnected, in which climate plays a significant role. Hence the Global Framework for Climate Services (GFCS) established by WCC-3 in 2009 will guide the development of resources that are urgently needed for enabling improved climate services, delivered in an operational manner to support initially four key priority areas, namely agriculture and food security; water; health and disaster risk reduction. This will be done by capitalizing on the existing capabilities through coordination and integration of existing initiatives and mechanisms and strengthening capacities where they are lacking. Mr Lucio informed the participants that the outcomes of the workshop will inform the “Dialogue for climate services users and providers: towards implementation of the Global Framework for Climate Services”, which will be held at the end of October prior to the Extraordinary Session of the WMO Congress.

2.3 On behalf of ADB, Winfried Wicklein, Deputy Country Director, ADB Resident Mission in Thailand welcomed all the participants. He mentioned that the LDCs, which do not emit much greenhouse gases but feel the impact of climate change in the form of increased frequency of droughts and floods. LDCs in Asia-Pacific are highly vulnerable and face many socio-economic challenges to start with. Climate change exacerbates the vulnerability, and the poor suffer the most. Environmental sustainability, including climate change, is one of the five core priorities under ADB’s long-term strategic framework and ADB is committed to mainstreaming climate change concerns into all our country strategies and operational plans. For the LDC client countries, ADB’s special focus is on adaptation or climate-resilient development, and strengthening of institutional capacity. Within the area of adaptation, ADB focuses on exactly the sectors and areas that will be covered at this workshop – water resources, agriculture, disaster risk reduction, and health. One of the new major global initiatives to assist LDCs is the Pilot Program for Climate Resilience (PPCR). The objective of the program is to demonstrate ways to integrate climate risk and resilience into core development planning. Mr Wicklein referred to a special session in the workshop which is devoted to examining the importance of climate services for the effective implementation of the PPCR.

2.4 Mr Man Ho So**,** FAO Deputy Regional Representative for Asia and the Pacific opened the workshop and mentioned that the workshop represents a truly important opportunity to strengthen collaboration between the respective agencies, country governments and other partner organizations to further progress toward the Global Framework for Climate Services and, in doing so, improve our capacity to manage climate variability and climate change. FAO believes that, realizing the agenda of the Global Framework to improve the availability and accessibility of climate services, will be crucial if we are going to overcome the considerable

challenges facing the agriculture sector in this region such as population growth, rapid urbanization, increasing competition for natural resources, environmental degradation and, most importantly, food insecurity. Human induced climate change and increasing climate variability will only complicate and compound these problems further - making the need for action under the Global Framework even more pressing. Mr Man Ho So emphasized that the workshop constitutes an important step toward realizing the vision encapsulated in the Global Framework to enable better management of the risks and opportunities arising from climate variability and change; particularly for vulnerable and developing countries in Asia and around the world.

3 LDCs and Climate Services

3.1 Mr Datius Rutashobya, Senior Programme Manager, Development and Regional Activities Department of WMO made a presentation on the WMO Programme for LDCs and the Istanbul Programme of Action. He mentioned that the 48 LDCs in the world with a- total population of 880 million represent the poorest and weakest segment of the international community and over 75% of LDC's population still live in poverty. The goal of the Istanbul Programme of Action (IPoA) for the Least Developed Countries for the Decade 2011–2020 is to overcome the structural challenges faced by the LDCs, eradicate poverty, achieve internationally agreed development goals and enable half of the 48 LDCs to graduate out of this category by 2020.

3.2 Among the objectives of the IPoA is the reduction of the vulnerability of LDCs to economic, natural and environmental shocks and disasters, as well as climate change, and enhance their ability to meet these and other challenges through strengthening their resilience. The WMO Programme for the LDCs supports the implementation of the UN Programme of Action for the Least Developed Countries for the Decade 2011–2020. The guiding principles of GFCS include priority for the most vulnerable countries (including LDCs) and the GFCS priority sectors (Agriculture, Disaster Risk Reduction, Water and Health) are among the IPoA priority areas of action.

3.3 Mr Rutashobya explained the purpose and scope of the WMO Programme for the LDCs and the activities of the programme. The main activities in favor of LDC include provision of technical equipment - weather observing systems, climate data management systems etc; education and training, participation in special meetings/training/events; advocacy, national and regional coordination workshops and seminars to promote the effective and beneficial use of weather-, climate- and water-related information and services in various key climate sensitive socio-economic sectors; and preparation of development and modernization plans of NMHSs. Mr Rutashobya described the implementation activities undertaken by WMO under the IPoA.

3.4 Mr Filipe Lucio, Head of the GFCS Office in WMO made a presentation on GFCS - towards improved decision-making in climate sensitive sectors. He mentioned that many countries lack the infrastructural, technical, human and institutional capacities to provide high-quality climate services. He described the concept of seamless hydro meteorological and climate services and those partnerships are key for the success of the GFCS. The vision of the GFCS is to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to climate-related hazards. Mr Lucio then described the prerequisites for climate services and the principles of the GFCS.

3.5 The GFCS short term priority areas include water, disaster risk reduction, health, and agriculture/food security. The operational infrastructure required includes technical infrastructure, global-regional-national interaction, best practices and standardized approaches and linking operational products with the applications. Mr Lucio then described the domain of operation of the GFCS at the global, regional and national levels and the potential national mechanisms.

3.6 Mr Lucio provided examples of climate services for the four priority sectors of the GFCS and the process for the development of the GFCS Implementation Plan. In summing up, Mr Lucio mentioned that the three key issues i.e., adaptation to climate variability and change,

disaster risk reduction and sustainable development and societal benefits are closely related issues and that the GFCS provides a good opportunity to address them.

4. Current Status of Climate Services in the LDCs of Asia

The session reviewed the current status of generating climate information in the LDCs in Asia, namely, Nepal, Bhutan, Lao PDR, Myanmar, Bangladesh, Samoa, Vanuatu and Maldives.

4.1 Nepal

4.1.1 Dr Rishi Ram Sharma, Director General of the Department of Hydrology and Meteorology (DHM) of Nepal reported that the existing observational network of the Department consists of manual stations and automatic surface observation systems. The manual stations include 173 precipitation stations, 72 climatic stations, 21 agro-meteorological stations, 9 synoptic stations, 7 aero-synoptic stations, 154 hydrometric stations and 20 sediment stations. The automatic surface observation systems consist of 14 automatic weather stations providing near real time data (air temp, relative humidity, precipitation, atmospheric pressure, wind speed and direction, solar radiation), 7 stations (air temp, relative humidity, rainfall), 51 rainfall stations providing near real time data, 7 weather stations (offline), 31 real time river gauge stations. Further, a few automatic weather stations with iridium satellite data transmission facility are under installations in high altitude.

4.1.2 Historical data from all the manual stations have been digitized since establishment up to 2010; 2011 data is under processing. Autographic charts have not been digitized yet. There is a new web-based database system (PostgreSQL 9.0) in Linux based environment. The database can handle both manual and automatic real time data from AWSs. Quality control is done in real time every 2 minutes. The database server is installed at the National Information Technology Center (NITC).

4.1.3 Climate data are provided to any end user upon their request. Observed station data is not free. Some minimal cost is associated with the data. Weekly, monthly, seasonal and annual reports are provided free of charge, in digital format.

4.1.4 Training on climate data analysis and interpretation and climate change projection (climate models) is needed for the staff working in climate section. Training on database, Linux, web etc. is necessary for staff working in data section.

4.2 Bhutan

4.2.1 Dr Karma Tsering of the Department of Hydromet Services of Bhutan described the current status of climate services in Bhutan. The Meteorological network consists of 20 class A Met stations, 73 class C Met stations, 9 AWS with real time data (10 m), 13 AWS (2 m) and 10 Wind Masts. The Hydrological network has 16 principal stations, 10 secondary stations and 10 sediment sampling stations. The Flood Warning network is composed of 15 flood warning stations and one GLOF EWS in Punkkha-Wangdi.

4.2.2 In the meteorological network, frequency of observation is once daily at 9.00, 12.00, & 3.00 BST for manual observations. For AWS, data logging frequency is of 30 minutes interval. Data are archived in the Hydata database system for manually operated stations (class A & C). Real-time data are archived MySQL software at data server. All data base is computerized and has consistent data record from 1996 for all stations and from 1990 for few stations and few from 1985. The major gaps are sparsely populated/no stations in Northern high lands; inadequate number of stations in some places; no snow gauging stations; no upper air observations and automation of stations is still at preliminary stage.

4.2.3 In the Hydrological network, most of the stations have more than 20 years of hydrology data. Currently there is no capacity to carryout comprehensive data processing and analysis (just checking and verifying calculation etc.). HYDATA v 4.2 is used as database as well as processing software. The major gaps are as follows: all hydrological stations are manually operated by observers; no real time data collection/transmission (data from manually observed stations in the field are sent through the post and reach headquarters after one month); most stations are located on big rivers and limited number of stations on tributaries where conflict and water uses are high and there is an inadequate number of hydrological stations (not all the rivers in Bhutan are covered).

4.2.4 Records from most climate stations start from 1985. Starting dates for other parameters are: Agromet stations (early 1990s), hydrology stations (1990), logger-based AWS (2003), real-time stations, i.e. AWS and AWLS (2007), GLOF-EWS (2011) and HYCOS stations (2012).

4.2.5 Currently, there are no meteorological activities directly addressing climate change. Data analysis products are provided to climate sensitive sectors. There is downscaling of GCM data to higher spatial and temporal resolutions. Activities addressing climate change and development of future hydrological and flood scenarios include modernizing of meteorological and hydrological network for collection of long time series from real time stations, installation of flood/GLOF EWS in river basins, establishing a Flood Forecasting and Warning center, and improving dissemination and warning information to relevant agencies and vulnerable communities.

4.2.6 Staff Strength consists of 25 professionals, 100 technicians and 25 support staff.

4.3 Lao PDR

4.3.1 Mrs. Souvanny Phonevilay, Deputy Director General of the Department of Meteorology and Hydrology (DMH) made a presentation on the current status of climate services in Lao PDR.

4.3.2 The DMH's roles and responsibilities include provision of Meteorological Services, Hydrological Services, Seismological Services, issuing of early warnings and training. The Meteorological Network consists of 49 surface synoptic observation stations (10 of which provide services to aviation) and 132 rain gauges. Data exchange via WMO's GTS.

4.3.3 Up to 1996, the climatic data was recorded manually. From 1997 to 2005, the DMH used CliCom software for climatic records. From 2006 to present, climate records have been computerized and also stored in hardcopy form. Regarding the lengths of data records, only 4 Synoptic stations have data available from 1951 up to date. For other stations, data is irregular, ranging 10-20 years, 20-30 years or some 40 years.

4.3.4 The current staff strength working on climate data and services is 16 (2 Master of science, one Bachelor, one Diploma and 12 technical staff.

4.3.5 The DMH provides rainfall outlooks in Laos for one month and three months**.** The DMH's sources of climate information include different forecast centers such as Tokyo Climate Center, Japan Met. Agency, ECMWF etc.

4.3.6 The Strategic goals of the DMH in Laos during 2011-2015 are towards actions that will build and strengthen the technical, professional, and institutional capacity of the DMH. These actions will address training, recruitment, modernizations of field observational systems, establishment of an early warning and data management centre, improved predictions and forecasts, a responsive research agenda, and enhanced public and community awareness for floods, droughts, earthquakes, and extreme weather.

4.4 Cambodia

4.4.1 Dr Pheav Sovuthy, Director, Department of Agricultural Land Resources Management (DALRM), Ministry of Agriculture, Forestry and Fisheries of Cambodia in his presentation made in Session 5 presented information on the current status of climate services in Cambodia.

4.4.2 Department of Meteorology (DOM) is under Ministry of Water Resources and Meteorology. Weather observation network in Cambodia consists of 20 synoptic stations including of 9 automatic stations (AWS), some are not working, while others are old and manual instruments.

4.4.3 Two hundred rain gauges (some of them automatically operated) were installed in most provinces, and these stations send rainfall data to the DOM center by telephone or telemetry data collection, or internet supported by MRC.

4.4.4 Weather forecasting is done through use of local data/information and also information from GTS and MTSAT and information from JMA, Hong Kong, NOAA, TMD and ECMWF. Provides general seasonal weather forecasts and severe weather warnings. Also weather note is provided to the Flood Management and Mitigation Center and a daily and 3-day Weather Bulletin to the Public through the Media and the Local Authority.

4.4.5 A Doppler radar has recently been established in the MOWRAM headquarters. It provides real time rainfall data with a maximum range of 450 km with Synergy: graphical user interface.

4.4.6 The DOM has been cooperating with all relevant government institutions and non-government organizations nationally and internationally.

4.5 Myanmar

4.5.1 Dr. Tin Mar Htay of the Department of Meteorology and Hydrology (DMH) of Myanmar described the status of climate services in Myanmar.

4.5.2 The meteorological observation network consists of 63 Meteorological Stations, 39 Hydro meteorological Stations, 17 Agro meteorological Stations, 1 Upper Air Station and 8 Aviation Weather Stations.

4.5.3 Users of Climate data and information are the agricultural and construction sector, fishery and forestry, health, information, relief and resettlement department, energy and research institute. The main users served by the DMH are Inland Water Transport, Navy of Myanmar, Myanmar Port Authority, Regions and States Authorities, Department of Civil Aviation, General Public via the Myanmar TV and Radio Department and Myanmar News Agency, Fishery and Agriculture Departments, Coastal Community, Fishery and Transport Company and Agencies, tourist companies and hotels, and NGOs/INGOs.

4.5.4 Installation of MTSAT and SATAID started from 2010 December, donated by JICA.

4.5.5 Future plans include the promotion of the Numerical Weather Prediction system; installation of the Regional Climate Model and WRF Model; substitution of conventional instruments with advanced instruments; installation of modern weather radars to cover the coastal regions; upgrading DMH's data collection and processing system; enhancing climate services, application and modeling; and training, seminars, workshops and scholarships

4.6 Bangladesh

4.6.1 The presentation of Md. Saiful Islam Khan, Assistant Director of the Bangladesh Meteorological Department (BMD) was made by Mr Md Ansar Ali from the Department of Agricultural Extension of Bangladesh.

4.6.2 BMD has 35 synoptic operational observatories plus 49 new ones. There is a plan to install AWS with real time telemetry within three years. There are 5 Radar stations (3 Doppler, 2 conventional), 4 operational seismic observatories and 4 earthquake Monitoring Stations. Data from all Synoptic, Pilot, Rawinsonde and Agromet observatories are received at the National Forecasting Centre (Storm Warning Centre) through Internet and SSB HF connection. Radar images are received through V-sat and microwave.

4.6.3 Forecast products are disseminated at national level to Local Government, electronic & print media through fax, telephone, dedicated digital communication, e-mail and web site. Recently all synoptic observatories have been networked by internet for the replacement of tele-printer connection.

4.6.4 Human capacity building of BMD is ongoing with grant from Japan. The components of the capacity building project include: operation and maintenance of radar and communication networks; capacity development on basic NWP system with regional model; climate data management and quality control; weather information dissemination programme; awareness build up programme for the school children; RADAR calibration for quantitative rainfall forecasting; and weather briefing. BMD is collaborating with the Norwegian Meteorological Institute in climate Product generation, visualization and analysis tool, and Numerical Weather Prediction

4.6.5 Future Plan and scope of BMD include introduction of seasonal forecast with statistical modeling; validation using different statistical techniques; GIS facility for graphical presentation and for easy understanding to end users; initiation of a 3-year pilot project with ADB finance where BMD is working as one of the implementing agencies to introduce weather index based crop insurance for the first time in Bangladesh.

4.7 Samoa

4.7.1 Mr Sunny Seuseu of Meteorology Division, Ministry of Natural Resources and Environment of Samoa made a presentation on the status of climate services in Samoa.

4.7.2 The observation network consists of 43 rainfall stations, 8 climate stations, 32 automatic weather stations, 2 tide gauges and 1 wind profiler.

4.7.3 CliDE database is used to securely store, manage and collate historical and current climate observations, and provides support for climate forecasts and warnings. 45% of climate records are already computerized.

4.7.4 Activities addressing climate change include the Pacific Climate Change Science Programme (funded by AusAid) has developed climate projections for Samoa using GCMs and climate trends from past climate. A climate risk profile has been developed and climate change adaptation for tourism is being developed. One of the outcomes of the climate change National Adaptation Programme of Action is to strengthen the capacity of Samoa's water resources managers and GIS planners to reduce the impact of climate change on groundwater resources. The GFCS priority sectors are covered under the national activities

4.7.5 The GFCS implementation plan will involve development of climate services in Samoa as a pilot project. The outcome will be more rapid implementation of sector-focused climate services for agriculture and food security, health, water and disaster risk reduction.

4.8 Vanuatu

4.8.1 Mr Nihmei Kaniaha Salesa, Head of the Climate Services Division of Vanuatu Meteorology and Geo-hazard Department described the current status of climate services in Vanuatu.

4.8.2 The observations network includes 7 Synoptic stations (RBSN, GCOS), 1 Upper Air Station (currently not working) and over 80 community-based rainfall sites. The community-based rainfall network is utilized for collection of traditional knowledge (TK) on weather and climate indicators and disseminating climate information and collecting climate impacts from the rural communities.

4.8.3 Climate data archiving, digitization has involved upgrading data storage facility and procedures; establishment of Database: CliCom (1990's), ClimSoft (2007), CliDE (2011); 13 month programme of digitization of historical data ending on 26 October 2012. There is need to digitize charts.

4.8.4 Climate Services products that have been developed need a communication strategy to be more effective and 'reach the last mile'. There is also need for tailor made services to cover the needs of sectors.

4.8.5 Development needs for climate services include: investment in capacity building for Climate Services; a strong communication strategy in-country to deliver informative services (to complement national strategies); strategy for implementation must include all players (churches and civil society); availability of a pool of experts and funds to support national driven strategies; regional strategy for strengthening services; recognition that community education is still key to the success of reaching the last mile; establishment of hazard based (GIS) database to capture hotspots or high risk communities to allow climate advice and projects to be targeted; documenting traditional cropping calendars for each crops and for each area and related to seasonal forecasting; automatic data capture from GTS and clear responsibilities through the development of policies and legislations.

4.9 Maldives

4.9.1 Dr. Zahid, Director Climatology of the Maldives Meteorological Service described the status of climate services in Maldives.

4.9.2 The observation network consists of 5 manned aviation and synoptic stations (visual observations), 20 AWS (11 of them not operational at present), 1 Upper air observing (RadioSonde) station (not operational at present), 1 Doppler weather radar (currently not operational), 3 Tide gauges, and an aviation weather workstation.

4.9.3 Data from all met stations are collected on a monthly basis and data from stations (hourly and daily) are received by email in excel sheets. These data are checked/quality controlled before they are archived in the database. Efforts are ongoing to identify requirements for developing a climate data base

4.9.4 Current activities addressing climate change include review of the existing National Building Code (NBC) through Tourism Adaptation Project (TAP) to Climate Change, which will address key infrastructure issues, and will formulate necessary policies, standards, codes and regulatory guidance that would facilitate necessary investments to increase the resilience of the tourist infrastructure to climate change. Formulation of guidelines for climate risk resilient coastal protection in the Maldives is underway.

4.9.5 Currently there are only 3 staff members working in the climate section of Maldives Meteorological Service (MMS). The total number of graduates working at the MMS is 4 which include one PhD, one M.Sc (Meteorologist), and two B.Sc (1 climatologist and 1 seismologist). There is a need to train about 4-6 staff up to graduate level to conduct climate research.

5. Needs for Climate Services, Current Status and Communication of Climate Information to Users in the Agriculture Sector

5.1 Bangladesh

5.1.1 Mr Ansar Ali, Project Director, Department of Agricultural Extension, Ministry of Agriculture of Bangladesh made a presentation on the needs for climate services for the agriculture sector in Bangladesh.

5.2 Cambodia

5.2.1 Dr Pheav Sovuthy, Director, Department of Agricultural Land Resources Management (DALRM), Ministry of Agriculture, Forestry and Fisheries of Cambodia spoke about the usage of climate related information by the Agriculture Sector in Cambodia. The Agriculture sector is the main economic driver in Cambodia, accounting for 34.4% of GDP and for more than 60% of the total employment in the country.

5.2.2 Cambodia's climate is humid to sub-humid tropical, with characteristically high temperatures, and two seasons are recognized: a monsoon-driven rainy season (May-October) with south-westerly winds ushering in clouds and moisture that accounts for between 80-90% of the country's annual precipitation, and a dry season (November-April), with cooler temperatures, particularly between November and January (transitional windy season).

5.2.3 Recent climatic trends in Cambodia show that Mean annual temperatures have increased by 0.8°C since 1960, at a rate of about 0.18°C per decade. Since 1960, the frequency of 'hot' days has increased significantly (+46, with strongest increases noted in September-November), as has the frequency of 'hot' nights (+63, with strongest increases noted in December-February). The frequency of 'cold' days has decreased significantly in September through February.

5.2.4 The southwest monsoons (May-October) bringing over three-quarters of the annual rainfall. As a result, floods along the Mekong River and its tributaries and from the Tonle Sap Lake constitute major disasters. Over the period 1998-2002, as much as 70% of rice production was lost to floods. Estimates suggest that floods kill 100 people annually, cause agricultural losses of US $100-170 million each year, and can significantly affect infrastructure along the floodplain.

5.2.5 Droughts impact every aspect of the country's economy and population, including leading to economic losses due to crop failure, health problems, and environmental damage. Over the period 1998-2002, a 20% loss in rice production was attributed to droughts. Droughts are already a common occurrence in Svay Rieng province, and projected rising temperatures could exacerbate an already vulnerable situation, pushing communities in the area beyond their coping capacities.

5.2.6 Climate is a dominant factor influencing food production and food security, therefore, there is a need and use of climate information and climate risk management at all levels, from farm to food market. Based on climate and other information: i.e. soil, biological and crop yield, Agro-ecological Zoning can be produced aiming to improve strategies for managing farming and natural resources efficiently. Climate information is also important for managing farm operations. Farmers have to make a crucial step of production decisions during the growing seasons based on climate conditions as well as other decisions concerning storage, trading, and finance. For example, scenario analysis was done using APSIM-ORYZA model to identify future viable crop and water options for adaptation.

5.2.7 Information, Research and Policy Gaps were described as follows. Most weather stations were manually operated and almost no real-time data collection and transmission. Both capacity building and services need to be improved. Meteorological information is sparse, and a country-wide network of hydro-meteorological stations needs to be established in order to

quantify long-term changes in climate, including benchmarking future climate variability and change. The use of existing meteorological information is limited to specific agencies, and this information needs to be tailored to decision maker s across a wider range of sectors, including agriculture and water resources management. Accurate and reliable local forecasts of extreme climate events are almost non-existent. Observation and forecasting systems need to be installed where appropriate, particularly in those areas that are heavily affected. Mainstreaming climate services and disaster risk management into planning and administration requires further research on appropriate mechanisms for mainstreaming. Inadequate technical, financial, and institutional capacity of government agencies and of local communities for dealing with climate services, as well as limited coordination among the relevant agencies and communities need to be addressed. There is limited integration of climate issues into national policies and strategic programs.

5.3 Lao P.D.R.

5.3.1 Mr Thavone Inthavong of the National Agriculture and Forestry Research Institute (NAFRI) made a presentation on the needs for climate services, current status and communication of climate information to users in the agriculture sector in the Lao PDR.

5.3.2 Agricultural production is highly dependent on climate, soil and water availability, and is adversely affected by weather and climate-related disasters. A solid understanding and making effective use of accurate, available climate information is therefore crucial to ensure food security, currently and also for the future.

5.3.3 The major climate constraints to agriculture in Lao PDR include uncertainty in the onset of rainy season affect time of sowing and transplanting and late season drought which affects reproductive stage of plant growth and development

5.3.4 Initial approach to characterization of agro-meteorological information is the production of rainfall distribution maps; development of weekly mean minimum and maximum temperatures (the relationship between temperature and altitude); crop evapotranspiration; use of soil water balance models; estimates of the start of the growing season, end of the growing season and the length of the growing season; estimation of yield reduction due to water stress.

5.3.5 Communication of climate information to users in the agriculture sector is done through the development of agroclimate advisories, and definition of wet and dry seasons.

5.3.6 Future priorities include maximization of the use of the currently available agrometeorological knowledge and technology; sharing experience on Climate forecasting; promotion of regional agrometeorological research; providing good agricultural practices based on sharing research results from other local and international research projects to support farmers managing their field in relation to climate change issues and developing new crop varieties (better adapted to different growing environment).

5.4 FAO Regional Office for Asia and Pacific

5.4.1 Mr Beau Damen, Bioenergy Officer and Climate Change Coordinator with the FAO Regional Office for Asia and the Pacific in Thailand made a presentation on climate services for agriculture in LDCs of Asia and the Pacific and mechanisms for improving interactions with users in the agriculture and food security sectors.

5.4.2 Mr Damen presented an overview of LDCs and agriculture and the trends in agricultural output. Global food yields have stagnated since 1995 and the aid for agriculture has declined. Hence agriculture and food security was identified as one of the 8 priority areas for action in the Istanbul Programme of action for LDCs for 2011 to 2020.

5.4.3 Climate services for agriculture include forecasts of typical weather related parameters such as rainfall and snow, maximum, minimum and dew point temperatures etc. and specific

agriculture related information e.g., dew and leaf wetness, pan evaporation, soil moisture, advice for irrigation timing etc.

5.4.4 The main climate services for agriculture include seasonal climate forecasts to provide forecasts of which variety to plant and when, when and where disease outbreaks are likely to occur or whether to reduce livestock numbers if a drought is forecast; Climate predictions: to be used by farmers for decisions on when to plant crops, quantity of water needed for irrigation or when best timing for spraying; Climate change projections: to be used to indicate precipitation and temperature patterns in the 30-to-50-year time frame to o guide major investment decisions relating to long-term water management such as whether and where to build new reservoirs. Crop yield scenarios are also available now; and statistical assessments of the future frequency of extreme weather and climate events: to help specialists for making decisions, including where to invest in disaster mitigation measures such as dams, where to locate buildings, which construction methods to use and how much heating and cooling is needed for critical infrastructure.

5.4.5 Areas requiring increased attention include improvement of forecast accuracy; evidence of forecast utility for climate risk management; enhanced stakeholder participation; communication with rural communities; learning from adoption failures; trade & storage applications and institutional and policy environment at national levels.

5.4.6 Mr Damen explained the different pillars in GFCS and in particular the User Interface Platform. GFCS is a crucial mechanism to improve provision of tailored climate services for LDC farmers and the GFCS user interface is context specific and depends on needs of the end users.

5.4.7 Basic considerations for improving interactions with users include understanding the sectoral perspectives and user needs; prioritizing the user needs to match the capability of information providers and available information sources; ensuring two-way feedback channels and enhancing capacity to interpret, communicate information, and use climate information; relevance to users in-terms of timing, scale, content, format etc.; considering user perception of climate impacts and local knowledge (local level); customizing value added information products at different levels (Global, Regional and National); and mechanisms to improve interactions should explicitly consider infrastructure, technical and institutional capacities.

5.4.8 Mr Damen then presented the mechanisms for improving user interactions using local level examples such as farmer workshops guided by decision support tools and methods; integrated weather and climate information services for food and agriculture at decentralized levels; and farmer field schools.

5.4.9 At the national level, mechanisms for improving user interactions include interactions between information providers (NMHSs) and users; national forums to prepare agro-advisories; integrating spatial data tools and management; developing enabling institutional networks and warnings of extreme events.

5.4.10 At the global level, FAO is disseminating the Global Information and Early Warning Systems (GIEWS).

5.4.11 Mr Damen ended his presentation with some key questions that need to be addressed when considering the needs for climate services of the end users in the agriculture sector.

5.5 Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

5.5.1 Dr Subbiah Arjunapermal, Director of the Regional Integrated Multi-Hazard Early Warning System (RIMES) in Thailand made a presentation on managing climate shocks to agriculture through Early Warning Systems.

5.5.2 Dr Arjunapermal presented information on climate sensitivity of agriculture sector through information on the percentage fall in agriculture GDP from potential due to extreme years in

selected LDCs from 2008 to 2011 and the potential savings in US$ if forecast information is used. For example, in Bangladesh there was a 19.4% loss in GDP and $1.1 billions could have been saved if forecast information was used.

5.5.3 Dr Arjunapermal presented the example of agricultural risk management in Bangladesh through flood spells management through long lead flood Early Warning Systems. The 24-48 hrs forecast is insufficient lead time to address community needs and the optimum lead time requirement is 10 days.

5.5.4 Dr Arjunapermal presented the project on Institutional Collaboration for Sustainable End-to-end Flood Forecasts System in Bangladesh which in 2008 resulted in economic benefits on average per household of $485 in the livestock sector, $180 in the agriculture sector and $120 in the fisheries sector.

5.5.5 According to World Bank, for every dollar invested, a return of $ 40.85 in benefits could be realized over a ten-year period.

5.5.6 Dr Arjunapermal presented another example of a pilot project on agricultural risk management through dry spell and wet spell management with 10-15 days Early Warning Systems which was pilot tested in India and is currently carried out in Nepal. He also presented the pilot project on supporting livelihoods of herders in Erdenedalai and Khotont of Mongolia through improved weather and climate information.

5.5.7 Institutional capacities in utilizing climate information for decision-making could be enhanced through Forums with key outcomes focused on articulation of user needs, highlighted capacity building needs and media training. RIMES have also been conducting forecast provider and user forums in different countries in Asia.

5.5.8 Case studies on investment in early warning in Bangladesh showed benefit/cost ratio of 40.85 for cyclones and 447.1 for floods.

5.6 CGIAR Research Program on Climate Change, Agriculture and Food Security

5.6.1 Mr Michael Sheinkman, Senior Advisor Food Security with the CGIAR Research Program on Climate Change, Agriculture and Food Security made a presentation on the needs for climate services, current status and communication of climate information to users in the agriculture sector.

5.6.2 As climate risk contributes to chronic poverty, vulnerability, food insecurity, there is a need for climate services for agriculture. Several opportunities to help agriculture adapt are dependent on information, but are constrained by information gaps. The types of climate information needed include historical observations, monitored data as well as predictive information at all lead times ≤ 20 years.

5.6.3 Special need of information for agriculture are that information should be downscaled, locally-relevant; tailored to types and timing of decisions; “Value-added” climate information for assessing impacts on agriculture and advisories; and the capacity to understand and act on complex information.

5.6.4 Mr Scheinkman described India’s Agromet. Advisory Service as an example of good practice. It covers Agrometeorological Field Units (AFU) in 127 agroclimatic zones. Multi-disciplinary research teams and AFUs prepare bi-weekly advisories: on weather, soil & crop conditions; irrigation, fertilizer, and pest control that is location- and crop-specific in local languages. Information is diffused through posters, mass media, phone (SMS and voice), Internet and in person. The service is scaling up from 3 to 12 million farmers in 2012.

5.6.5 An example of gap is the tailoring of seasonal forecasts to agriculture’s needs. There is a mismatch with needs of farmers in terms of spatial scale and the seasonal rainfall total.

5.6.6 The Climate Change, Agriculture and Food Security (CCAFS), a research program of the CGIAR, focuses on pro-poor adaptation and mitigation practices, technologies, policies for agriculture and food systems and supports inclusion of agriculture issues in climate policies and climate issues in agricultural policies.

5.6.7 Theme 2 of CCAFS on "Adaptation through managing climate risk" puts emphasis on climate information and services and Mr Scheinkman described some pilot projects being undertaken under this theme.

6. Needs for Climate Services, Current Status and Communication of Climate Information to Users in the Water Sector

6.1 Bhutan

6.1.1 Mr Karma Chhopel, Chief Environment Officer, Water Resources Coordination, National Environment Commission made a presentation on the needs for climate services in the water sector of Bhutan.

6.1.2 Bhutan has 10 protected areas representative of different ecosystems. About 51.4% of the area in the country is covered which includes 42.71% under protected area, 8.61% under biological corridors and 0.12% under conservation area.

6.1.3 Bhutan is a water rich country as it receives rainfall for about 150 days in a year which makes hydropower to the extent of 23,760 MW feasible.

6.1.4 Emphasis is placed on Integrated Water Resources Management (IWRM) which is "A process, which promotes the coordinated development of water, land and other related resources to maximize the resultant economic & social welfare in an equitable manner without compromising the sustainability of the vital ecosystems".

6.1.5 Climate change is leading to drying of water bodies, decreasing snowfall, unpredictable rainfall patterns and increasing frequency of windstorms, rainstorms and thunderstorms.

6.1.6 There are 2,674 Glacial Lakes and 677 Glaciers in Bhutan. Due to climate change, there is now a rapid melting of glaciers (20-30 m annually). There are 24 potentially dangerous lakes. Through a multidisciplinary approach, the artificial lowering of the water level at Throthorme Lake by 5m was recently completed. This work started in 2009 and was completed in 2012.

6.1.7 Climate change adaptation measures include investing in alternative sources of energy (solar, wind, biogas), building check-dams and water reservoirs using natural contours of riverbeds, promoting rainwater harvesting and promoting dry land (conservation) agriculture.

6.1.8 Gaps in climate services include climate modeling and hydrological modeling to improve weather forecasting, flood forecasting and early warning (technology, human and financial resources); in-situ and ex-situ monitoring of snow and glaciers (no snow gauging stations); inadequate number of hydrological stations (not on all river systems) and study of glacier ice volume change in relation to river flows

6.1.9 There is an urgent need to strengthen Himalaya specific climate services, hydro-meteorological observation network stations and database management. There is also urgency for designing effective adaptation strategies at the micro-level and for continuous improvements in the precision of prediction of future climate patterns over small areas in the Himalayas. Precise assessment of the impacts of climate change to develop adaptation strategies will be very difficult without a strong Himalaya Specific water science

6.2 Bangladesh

6.2.1 Mr Md. Mosaddeque Hossain, Superintending Engineer, Bangladesh Water Development Board (BWDB) described the needs for climate services for the water sector in Bangladesh.

6.2.2 About 50% of the country is below 7.0 m of MSL and about 68% of the country is vulnerable to floods. During normal floods, about 25 to 30% of the area is inundated.

6.2.1 Bangladesh is the biggest delta of the world with 405 rivers. It is the lower riparian country of the three largest river systems (Ganges-Brahmaputra-Meghna) with 57 Transboundary Rivers: 54 from India and three from Myanmar. About 22,000 km^2 or 8% of the country is covered by Open Inland Water Bodies of Bangladesh.

6.2.2 Bangladesh Rivers receive runoff from a catchment of 1.72 million sq-km, around 12 times its land area.

6.2.3 Water-related issues or challenges include: floods (Flash Flood, River Flood, Coastal Flood), river bank erosion, storm surge, salinity problems in coastal area, scarcity of water during dry period and silt and sediment management.

6.2.4 River erosion causes an annual land loss of 6000 ha and leads to annual displacement of 50,000 people. Agriculture in the country is highly dependent on water management (Flood Management and Irrigation).

6.2.5 BWDB Surface Water (Hydromet) and Ground Water network is very mature and has excellent Spatial coverage throughout Bangladesh to monitor surface water (discharge, water level, sediment), climatology (rainfall , evaporation, temperature etc.) and ground water observation well (GWL and quality).

6.2.6 Major gaps in the network are manual data collection systems (lack of automatic data collection system except three stations for water level and rainfall – under HKH -HYCOS Project); human error and negligence in data collection; operation and maintenance problems and modernization of the data acquisition system.

6.2.7 Needs of climate data and climate information in the water sector include: understanding of the climate change trend; data for water resources planning and designing of hydraulic structures; climate change adaptation program; rainfall data for flood forecasting and prevention of drainage congestion and water logging that may result from heavy rainfall in urban areas.

6.2.8 Recommendations for the water sector include up-grading of the existing network system; real time automated data acquisition, processing and dissemination system; capacity building (both human resources and institutional); and flash and coastal flood forecasting.

6.3 Asian Development Bank

6.3.1 Dr Charles Rodgers, Senior Environment Specialist in the Asian Development Bank made a presentation on the effective use of climate services for water resources management in the context of climate change.

6.3.2 Climate change projections will be increasingly important components of climate services as they provide the basis for many studies of adaptation in the water sector. By over-emphasizing (over-interpreting) such projections, the analysis can be driven by the supply of, rather than on the demand for climate information and services. However, decision makers can be helped by a shift of emphasis from the scenario-first perspective (often involving extensive uncertainty) to a decision-led view. The first step is to quantify the sensitivity domain of the managed system under a wide range of climatic and non-climatic pressures.

6.3.3 Two broad approaches are used to guide adaptation planning and the identification of appropriate interventions in the water resources sector: impact ("top-down") assessment

emphasizes the central role of climate projections in guiding decision-making; and vulnerability ("bottom-up") assessment emphasizes the location-specific context and examination of existing vulnerabilities, infrastructure operational tolerances and institutional arrangements

6.3.4 Dr Rodgers described two case studies: City of Seattle Municipal Water Supply Planning: vulnerability assessment illustrating the importance of including non-climate factors (e.g., demand); the importance of identifying timeframes for intervention to manage uncertainty in climate information; and Long-term planning of water and irrigation infrastructure in Brantas Basin (East Java, Indonesia), illustrating the "stress test" approach and the use of climate projection information to evaluate risk quantitatively

6.3.5 Model-generated projections of future climate are essential climate services in adapting the water sector to climate change, and their importance will increase over time. However when adaptation activities are "supply-driven", there is a danger that projections are over-interpreted; that uncertainty is discounted, and that the wrong kinds of questions will be asked (or the right ones not asked).

6.3.6 Attention should be focused on the water system of interest, and the proper role of model-generated projections is to inform, rather than drive, the analysis. A vulnerability-based analysis will assist in making the most effective use of climate information and services by identifying the most important variables, the critical time-scales, and the "consequences of being wrong".

7. Needs for Climate Services, Current Status and Communication of Climate Information to Users in the Health and Disaster Risk Reduction Sectors

7.1 World Health Organization (WHO)

7.1.1 Dr Khalil Rahman, Coordinator of WHO Liaison Office with the United Nations Economic and Social Commission for Asia and the Pacific presented the perspectives from WHO on the needs for climate services.

7.1.2 In the last decade, more than 200 million people were affected and more than 70,000 people killed by natural disasters annually in Asia-Pacific region - 90% and 65% of the world totals respectively. In 2008, death toll from natural disasters tripled to 235,000 from an annual 66,000 between 2000-2007. While in the Asia-Pacific, high income countries, about 1000 people were affected and 1 million died; in the low-income countries, nearly 30,000 people were affected and 52 million people killed between 2001 to 2010.

7.1.3 In 1991, a cyclone in Bangladesh killed about 140,000 people. In 2004, the tsunami left 130,000 people dead, 37,000 missing and 500,000 people displaced in Indonesia. Damages and losses were estimated at US$4.8 billion. The tsunami killed about 227,898 in total (US Geological Survey) and affected 15 Indian Ocean countries. The cyclone Nargis killed over 138,000 people in Myanmar. These created loss and damage to health facilities.

7.1.4 Dr Rahman provided a few examples of health impacts of climate change: prevalence of night blindness increased after the devastating floods of 1988 in Bangladesh. The Cyclone Sidr in Bangladesh increased the numbers of diarrhea, respiratory tract infection, and eye infection, various skin diseases, and fever. Most of these were caused by a shortage of clean drinking water (ADPC 2010). Mass displacement of people, social instability, worsening poverty due to income loss and the influx of new populations, including construction and relief workers, soldiers and transporters are factors associated with increase in sexually transmitted diseases including HIV/AIDS.

7.1.5 The most commonly known impacts of climate change are the emergence, resurgence and expansion of, e.g., dengue, malaria, leishmaniasis, schistosomiasis, Nipah virus disease, leptospirosis, typhus, diarrhoea, asthma, skin cancer, heat stroke and cardiac failure, malnutrition and probably avian flu and some other viral infections. Mental health problems, family discord, social disruption, migration, poverty and malnutrition are caused by extreme

weather conditions and also some slowly evolving climate change impacts. The extent of the psycho-social and the economic damages caused by the climate impacts and the other health problems including death and injuries are yet to be estimated in economic terms.

7.1.6 WHO provides technical support to develop country specific tools for assessing health vulnerabilities of the people and the health sector and to develop strategies in the Member States for addressing health impacts of climate change. WHO also organizes training for Member States focal points on climate change and health, based on the initial findings and the regional strategy and the regional assessment tool for health vulnerability, which were developed by SEARO recently. WHO collaborates with other relevant organizations and agencies like WMO, UNEP, universities and other relevant agencies for climate services, including research.

7.2 Asian Development Bank

7.2.1 Mr Arghya Sinha Roy, Disaster Risk Management Specialist (Climate Change Adaptation) with the Asian Development Bank made a presentation on the needs for climate services for the disaster risk management in the LDCs.

7.2.2 The evolving landscape for Disaster Risk Management (DRM) involves a paradigm shift from reactive to proactive approaches to protect lives and livelihoods, reduce disaster risk and develop systems for better managing residual risk.

7.2.3 Disaster risk is beyond managing hazards; equally about reducing vulnerability and limiting exposure to hazards and is inclusive to address gender and vulnerable population.

7.2.4 LDCs more vulnerable to disasters caused from natural hazards because of high level of poverty and constraints which include limited resilience to vulnerabilities (Highest ratio of economic loss to capital stock and low national savings, thus less capacity to absorb impacts and recover), high population growth, severe infrastructure deficit and lack of adequate governance capacities.

7.2.5 Climate services for better DRM decision making require climate information across timescales and policy relevant and improved understanding on how to use the information

7.2.6 Historical climate information is essential for quantifying hazard characteristics – frequency, severity, location of climate extremes and for understanding how risk is constantly changing based on seasonality, inter annual climate variation, change in population and exposure. It also provides a context for interpreting climate conditions and trends. There are however limitations - gaps in data and quality.

7.2.7 Longer lead time in weather forecasts improves coordination for response and for mobilizing human resources, supplies, and activating contingency plans. The challenge here is limitations in reaching ‘last mile’ and ‘user friendly formats’.

7.2.8 Seasonal forecasts are the starting point for preparedness planning; stockpiling, mobilizing resources and flood preparedness plans. The challenge here is the need to move beyond preparedness for ‘event based response’ rather to prepare for ‘climate outlook based response’.

7.2.9 Multi-year and decadal forecasts are valuable for informing strategic DRM investments, risk financing, and policy decisions. There is a need for advocacy for using climate scenarios in infrastructure planning and livelihood planning (sectoral).

7.2.10 In creating an enabling environment for resilient development, there is a need to look at climate services as not an end in itself, but to raise awareness and education, and enhance coordination. There is also a need to strengthen capacity to generate, disseminate and use information.

7.2.11 Climate information needs to feed into risk assessments and there is a need to look beyond national boundaries - trans boundary hazards by strengthening regional cooperation.

7.3 Asian Disaster Preparedness Centre

7.3.1 Dr Senaka Basnayake, Department Head, Climate Change and Climate Risk Management of the Asian Disaster Preparedness Centre (ADPC) made a presentation on Climate Services in DRR sector in Cambodia and Lao PDR.

7.3.2 About 80 percent of Cambodia's territory lies within the Tonlé Sap and the Mekong River basins. The large fluctuations of water levels between the dry and wet seasons cause a cycle of droughts and floods almost every year, damaging agricultural production and livelihoods, constraining Cambodian development and poverty alleviation. Floods are estimated to kill about 100 people and cause agricultural losses of 100 to 170 million USD annually while also causing damage to infrastructure, public facilities, and household properties. Severe droughts are likely to continue due to underdeveloped water resource management facilities, environmental degradation, and extreme climate events.

7.3.3 Royal Government of Cambodia (RGC) established the National Committee for Disaster Management (NCDM) in 1995 that has the responsibility for disaster risk reduction, mitigation, preparedness, response, and recovery. The NCDM has been mandated in coordinating and implementing "National Action Plan and Strategy on Disaster Risk Reduction 2008-2013" which includes six major components as follows - Ensure disaster risk reduction in preparedness for emergency response at both the national and grassroots levels; Strengthen the management of disaster risks and preparedness for emergency response at sub-national and community levels; Identify, assess and monitor disaster risks and enhance early warning systems; Use knowledge, recent findings and education to build a culture of safety and resilience at all levels; Mainstream reduction risk in policies and programmes of concerned ministries and institutions; and strengthen preparedness for effective response to disasters at every level.

7.3.4 The Ministry of Water Resources and Meteorology (MOWRAM) (established in 1999) is mandated to produce and disseminate forecasts to the entire country. Regional Flood Management and Mitigation Center (RFMMC) of the Mekong River Commission (MRC) and MRC Flash Flood Guidance System (MRCFFGS) are responsible for producing and disseminating flood forecasts and early warning information for its member states in the Lower Mekong Basin. At the local level, the Cambodian Red Cross plays an important role in disseminating flood forecasts to the communities.

7.3.5 The forecast and early warning information is disseminated by MOWRAM regularly during flood season (June to November) through television, mass media, FM and AM radio channels, and local newspapers. However, the capacity of MOWRAM across all levels is limited due to insufficient funding, dated communication systems, and lack of equipment. The monitoring of floodwaters, droughts, and other disasters is reasonably effective; the forecast and early warning information from the national level usually reaches existing networks at the provincial but not the commune level. It was noticed that dissemination of early warnings of Ketsana to communities at risk was very week.

7.3.6 There are several forums and platforms in Cambodia both from the Disaster Risk Management practitioners as well as among the agencies involved in Climate Change adaptation in the country. Following networks and platforms are the more prominent for hydro-meteorological disaster mitigation and may be tapped for consultation: The Disaster Risk Reduction Network for Cambodia (DRR Net) and corresponding "DRR Forum" facilitated by National Committee for Disaster Management (NCDM); Joint Action Group (JAG) for disaster risk management facilitated by the EC grand recipient agencies and partners and Monsoon Forum" facilitated by the Ministry of Water Resources and Meteorology (MOWRAM).

7.3.7 In Lao PDR, floods, droughts and landslides are hydro-meteorological hazards which cause high economic losses and social consequences, particularly for poor and vulnerable rural and urban groups. National Disaster management Office (NDMO) in Lao PDR was established

in 1997 with support from UNDP. A landmark decree, signed by the Prime Minister in August 1999, provided an inter-ministerial National Disaster management Committee (NDMC) as a policy making and coordinating body. The NDMO functions as the Secretariat of the NDMC.

7.3.8 National Needs for climate services in Lao PDR and approaches for improvement include cross-sector collaboration among national stakeholders; and international cooperation; capacity building including the establishment and enhancement of hydro-met and climate monitoring facilities with data collection in both automated surface-based and satellite-based systems; training of professionals and practitioners on modeling techniques; training on climate downscaling techniques and applications focusing on hydrologic-hydrodynamic models, CC impacts assessment in flood and drought problems and Agro-climate services; training on climate analysis systems and long term projection tools; and training on operational forecasting and early warning dissemination.

7.4 Maldives

7.4.1 Mr Afsal Hussain, Environment Analyst in the Ministry of Environment and Energy made a presentation on the climate services for the disaster risk reduction sector in Maldives.

7.4.2 The Republic of Maldives consists of 1,190 small coral islands and the total land area is less than 300 km. Twenty administrative atolls, 198 islands are inhabited, about 90 islands are resorts, and some are used for agriculture. The country is low-lying with the highest point 2m above mean sea level. Maldives has very little in terms of freshwater resources. There are practically no surface water sources.

7.4.3 Disaster risks arise from heavy rainfall during the monsoon, tidal surges, flooding, tsunami, and water shortages in dry periods.

7.4.4 The National Disaster Management Center (NDMC) works as an entity under the Ministry of Defence and National Security and functions to prevent, prepare, respond, and to conduct recovery operations for all National level Disasters. The Disaster risk reduction progress score (1-5 scale; 5=best) in Maldives was last reported at 2.25 in 2011, according to a World Bank report published in 2012.

7.4.5 Climate data and climate information in the DRR sector are needed to enhance strategic developmental plans and propose cost-effective, economically viable schemes towards environmental friendliness and sustainability.

7.4.6 Information on DRR to user communities is provided upon formal requests to relevant sectors, through the Provincial Information Management System (Data Portal), e-Government Portal and National Geographic Information System (NGIS).

7.4.7 The challenges include: lack of institutional and financial capacity for establishment, operation and management services; scattered geography; land constraints; lack of trained personnel; lack of legislative framework, laws and guidelines; and lack of capacity to respond in an emergency and in mitigating the impacts of climate change (water shortages during dry periods).

7.5 Nepal

7.5.1 Dr Jay Ram Adhikari, Under Secretary (Technical), Ministry of Environment, Science and Technology of Nepal made a presentation on the needs for climate services from the DRR sector in Nepal.

7.5.2 Nepal is a disaster-prone country mainly due to its young geology, heavy monsoon rain and mountainous terrain. Major types of disasters in Nepal include floods, earthquakes, droughts, landslides, epidemics, Glacial Lake Outburst Floods (GLOFS), and fire. Less devastating disasters include avalanches, rainstorms, and hailstorms.

7.5.3 Climate change and variability in weather patterns too have aggravated disaster vulnerability in Nepal. Nepal emits 0.025% of global emission but is the 4th vulnerable country in terms of climate change. Temperature raises 0.06 °C/year with high rate in mountain and winter season (1977-1994). The Risk of Glacial Lake Outburst Floods (GLOFs) has tremendously increased because of climate change.

7.5.4 Earthquakes are an infrequent hazard event, but Nepal is considered to be a high seismic-risk country. Kathmandu valley is exposed to the greatest earthquake risk among 21 megacities in the world.

7.5.5 National Strategy for Disaster Risk Management (NSDRM) of 2009 is aligned with the Hyogo Framework of Action (2005). The DRR and CRM focal points system has been established and a National Emergency Operation Center is established under MoHA to coordinate the emergency response services for 24 hours.

7.5.6 The Government of Nepal has endorsed the National Strategy for Disaster Risk Management (NCDRM) on 11 October 2011, which is considered a milestone in the DRR in Nepal. The NCDRM has a provision of constituting a high level National Council for Disaster Management (NCDM) chaired by Prime Minister.

7.5.7 The First National Action Plan on Disaster Management was prepared in 1996. The DRR was included in the 10th five-year plan (2002-2007). The plan envisaged to prepare maps of the areas vulnerable to the various disasters and integrate it into geographical information system for 20 districts. A three year Interim plan of 2007 to 2010 recognized the impact of water induced disaster and aimed to have its prevention strategy such as short-term, medium-term and long-term programme.

7.5.8 The third priority area entitled “Better knowledge management for building a culture of safety” of the National Strategy for Disaster Risk Management (NSDRM) has a dedicated web portal on Climate Change Knowledge Management and Learning Platform (www.climatenepal.org.np); a public-accessible CC Knowledge Management Centre, and a Multi-stakeholder CC Initiatives Coordination Committee (MCCICC) chaired by Secretary MoEST.

7.5.9 Currently there are eight ongoing projects and programmes on Climate Change and DRR in Nepal.

7.5.10 There are a number of challenges that need to be addressed which include: weak coordination between hydro-meteorological services (HMS), providers and DRR community; difficulties in ensuring timely, accurate and high-quality scientific weather and hydrological information and services; poor and inadequate distribution of Flood Forecasting Network; poor precipitation station network from Siwalik to Mountain (300-2500 m altitude); inadequate understanding/knowledge among DRR and various development stakeholders; lack of understanding on the importance of climate and water information for informed decision making and reducing risks to the economy; low Priority to HMS by government and political authorities; limited financial resources; lack of trained personnel; poor observation network of HMS; poor telecommunication facilities/models/technical inputs; and poor ability to detect extreme events/climate change trends.

7.6 International Federation of Red Cross and Red Crescent Societies (IFRC)

7.6.1 Ms Indira Kulenovic, Regional Community Safety and Resilience Unit (DM &Health) of the International Federation of Red Cross and Red Crescent Societies made a presentation on “Climate Change and the Red Cross and Red Crescent”.

7.6.2 Weather related disasters doubled over the past two decades with increase in small-and medium-scale disasters and more uncertainties. The changing patterns impact disaster management, food security, health, water and sanitation.

7.6.3 At the Red Cross Red Crescent (RCRC) International Conference in 2007 'Together for Humanity', commitments were made to address climate change in the following ways: raise awareness on climate change; provide humanitarian assistance; improve capacity to respond; decrease vulnerability of communities most strongly affected; integrate climate risk management into policies and plans; and mobilise human and financial resources, giving priority to actions for the most vulnerable.

7.6.4 RCRC perspective in this regard is risk reduction (and preparedness): invest in community resilience before disasters happen. The response is to prepare for more but also smarter response operations.

7.6.5 The Climate Centre of RCRC has been engaged since 2002 in the following activities: assisting NS with knowledge on combining/bridging CCA and DRR; focusing on "Triple A" principle: Awareness, Action and Advocacy + Analyses; preparation of RC/RC Climate Guide, Early Warning Early Action Guide; "A better climate for DRM" – a book jointly published by IRI, Climate Centre and IFRC and a case study such as "Making climate information user friendly for humanitarian organisations".

7.6.6 In the Preparedness for Climate Change Programme, RCRC has been engaged in the following activities: cooperation with Meteorological office; building new partnerships; information campaigns; dialogue and communication; understanding climate risks at local level; and action plans.

7.6.7 Forecasts are useful for humanitarian decisions for the kind of early actions that should be taken in the short, medium and long terms. Early Warning – Early Action approach needs good information that everybody understands; a way of disseminating it; awareness of local context and the capacity to turn warning into action.

7.6.8 In ensuring that information is available and it reaches the most vulnerable, it is necessary to recognize that technology for technology sake is not enough to save lives. Translation of scientific data and flow of information from global, regional, national and most importantly to community level needs serious improvements. There is a multitude of climate information resources in Asia Pacific region but there is not a single tool that is comprehensive enough to support early warning for all hazards and all locations. High level technical information needs to be coupled with community based application if we want to make a difference.

7.6.9 Climate Services need to support: timely dissemination of information understood by communities – the most vulnerable and decisions based on forecasts that can reduce climate risk. By considering forecasts across timescales, the Red Cross/Red Crescent can improve community resilience, create action plans for predictable hazards and be more effective before, during and after emergencies.

8. Climate Risk Management in Asian LDCs: Some Insights from Pilot Programme for Climate Resilience (PPCR)

8.1 Asian Development Bank (ADB)

8.1.1 Dr Ancha Srinivasan, Principal Climate Change Specialist, Asian Development Bank made a presentation on "Climate Services for Effective Implementation of PPCR: An Overview".

8.1.2 The Pilot Project on Climate Resilience (PPCR) is part of the Strategic Climate Fund (SCF) under the umbrella of the Climate Investment Funds (CIF). It aims to pilot and

demonstrate ways in which climate risk and resilience can be integrated into core development planning by providing incentives for scaled-up action and initiating transformational change. Nine countries and 2 regions (Pacific & Caribbean), covering a total of 18 countries selected as pilot participants. Funding of over $1,100 million was pledged by developed countries. As of 8 October 2012, 14 of the 18 Strategic Programs for Climate Resilience (SPCR) from pilot countries and regions have been endorsed by the PPCR Sub-committee. PPCR is implemented jointly by AfDB, ADB, EBRD, IDB, WB, and IFC (ADB, WB and IFC in Asia). Asian PPCR countries include: Bangladesh, Cambodia, Nepal, in the Pacific: Samoa, Tonga, PNG and Tajikistan and Yemen.

8.1.3 The expected outcomes of PPCR include the following: An increased capacity to integrate climate resilience into country development strategies; a more inclusive approach to climate resilient growth and development; an increased awareness of the potential impacts of climate change; scaled-up investment for broader interventions and programming related to climate resilience; and improved coordination among stakeholders regarding country-specific climate resilient programs.

8.1.4 Typical activities that are supported in the PPCR include the following: Improving agricultural practices and food security; building climate-resilient water supply and sanitation infrastructure; conducting feasibility studies for climate-resilient housing in coastal areas; and monitoring and analyzing weather data and other climate services ($50 M through PPCR + $95 M co-financing).

8.1.5 Climate Services in PPCR have developmental relevance: establishing a clear baseline (climate change detection); better understanding of current and future climate (Improved monitoring & observation equipment; climate change modeling; climate prediction and Enhanced forecasting ability); reduced losses (Inputs to early warning systems); improved ability to adapt (research on adaptation measures); enhanced social protection (methodologies and tools for improved resilience); and informed development in key sectors (Capacity building & institutional improvements; diffusion of the know how on climate services).

8.1.6 PPCR presents an excellent opportunity for knowledge sharing on climate services. Types of Climate Service Improvement in selected PPCR countries in Asia and the Pacific include: early Warning Systems, improved equipment, better observations, improved forecasting, improved climate change modeling, capacity building and institutional improvements, and research.

8.1.7 Support via PPCR could be extended to the priority sectors in GFCS as follows: Agriculture (seasonal forecasts, index-based weather insurance); Water Resources (river flow management, flood warnings); Disaster Risk Reduction (early warning systems); Health (outbreak warnings for diseases, changing disease vectors).

8.1.8 Climate service related challenges in the PPCR countries include: weak institutions, lack of basic observation infrastructure and lack of relevant weather, hydrological and climate information make it difficult to design and build climate-resilient infrastructure; inadequate capacity to provide data and degradation of such ability during the last 15-20 years; deterioration of observation networks and outdated technology; lack of modern equipment and forecasting methods; insufficient R&D support; erosion of workforce, lack of trained specialists; poor quality of services; lack of a systematic and integrated (NMHS-wide) ‘end-to-end’ approach that removes bottlenecks and inefficiencies; poor links with sector specialists and limited understanding of the user needs; and limited investments due to lack of appreciation of real economic benefits of climate services.

8.1.9 To improve the situation a number of steps can be taken which include: enhancing awareness on significance of and options for mainstreaming climate services into development at policy and operational levels; improving technical guidance on modernization of climate services in a step-wise manner; strengthening human capital in climate services; packaging

modernization of climate services within larger projects in agriculture, water resources, disaster reduction, and public health; providing targeted financing to arrest degradation of climate services in LDCs (Making meteorological and hydrological agencies the center of support, and helping them to raise their profile within the government using results of economic assessments/CBA& analytical work); designing new business models and sustainable and innovative investments for climate services through creative use of long-term financial instruments such as AF, PPCR, GCF; strengthening the public-private partnerships in climate services by raising the awareness of the private sector on new business opportunities (equipment supplies, consulting services, turn-key solutions for modernization of NMS and ICT, knowledge solutions & applications in various sectors) and climate threats to business sustainability; and improving coordination among donors, and building partnerships with WMO, ISDR, ADPC, leading NMHSs (NOAA NWS, UK Met, FMI, MeteoSwiss, etc.) global forecasting centers, IFIs & private sector

8.2 Bangladesh

8.2.1 Mr Arif Faisal, Environment Specialist, Bangladesh Resident Mission of Asian Development Bank made a presentation on “Climate Services in Implementation of SPCR in Bangladesh”.

8.2.2. Bangladesh, one of the most vulnerable countries to climate change with one of the highest population densities worldwide, has been witnessing increasing frequency and intensity of climate induced disasters including salt water intrusion due to sea level rise. Climate change and variability are significantly affecting the country’s climate sensitive development sectors like agriculture, water resources, forest, fisheries & livestock, infrastructure & settlement, health, and social services.

8.2.3. Major components of the Strategic Programme for Climate Resilience (SPCR) in Bangladesh is scaled up climate resilient investment in agriculture, coastal defense through climate proofing of coastal embankments, rural infrastructure & greenbelt, water supply & sanitation, improved coastal connectivity, funding for climate resilient housing, etc. including capacity building and knowledge management. PPCR support is $110 m ($ 50 m grant & US$ 60 m concessional loan)

8.2.4. Design and implementation arrangement of SPCR is through a single technical assistance project proposal emphasizing an integrated cross-sector approach with geographical focus and adaptation investments and activities in the most vulnerable coastal zones covering 12 most climate vulnerable hotspots in coastal areas. The program ensures effective coordination mechanism and institutional arrangements through coordination and implementation through one lead ministry. There are possible entry points for leveraging the private sectors.

8.2.5. The Government of Bangladesh spends nearly $4.7 billion in development projects in its eight development sectors; around $2.7bn of investment is now at risk due to climate change. The government typically spends around 6% to 7% of its annual combined budget on climate sensitive activity which equates to an annual sum in the region of US$1 billion.

8.2.6. The major project components climate services in Bangladesh address adaptive agriculture and efficient irrigation, water management, cyclone shelter, climate proofing of coastal infrastructure, livelihood diversification in vulnerable areas, health and social protection, disaster management, coastal afforestation and greenbelt areas for coastal protection.

8.2.7. Areas that need more attention include livelihood protection in vulnerable and fragile areas; community health, social service and climate migrant; rehabilitation of most vulnerable community and displaced persons; adaptation in fisheries, livestock, poultry and other NRM; adaptation in urban areas and other vulnerable municipalities; adaptation in drought prone areas; adaptation in vulnerable & ecologically critical ecosystem (e.g. wetlands, coral reefs, mangrove, etc.); gender consideration in climate change management; institutional strengthening &

capacity development; regional cooperation in CCA & DRM; research and knowledge management; improving climate modeling & weather forecasting; climate fund governance & facilitation for improve access to global climate fund and monitoring and evaluation for tracking adaptation.

8.2.8. For improving the climate services in Bangladesh, improved coordination mechanism is underway. Losses of institutional memory and technical pools could be addressed through creating cluster of associated sectors and transferring the govt. staff within those relevant sectors to retain institutional memory. Government of Bangladesh started country specific prioritized research/study in climate change adaptation and disaster risk reduction to fill the current knowledge gaps. Improvements in communication mechanism are developing.

8.3 Nepal

8.3.1 Dr Rishi Ram Sharma, Director General of the Department of Hydrology and Meteorology (DHM) of Nepal made a presentation on "Some Insights of PPCR: Nepal's Perspective".

8.3.2 The SPCR in Nepal has five components. The objectives of Component 2 on "Building Resilience to Climate Related Hazards" are to diminish the impacts of extreme climate related events; protect lives and assets and support agricultural livelihoods by establishing multi-hazard information management system, improving the accuracy and timelines of weather and flood forecasts and warning.

8.3.3 This component with a total budget of $ 31 million has four sub-components: institutional strengthening, capacity building and sustainability of DHM ($5.1 million); modernization of the observation networks and forecasting ($16.45 million); enhancement of the service delivery system of DHM ($3.45 million); and DHM climate and weather information for users in agriculture – Agriculture Management Information System ($6 million). Each of these sub-components has well defined activities.

8.3.4 DHM has a procurement plan for goods, works, consulting services and non-consulting Services

8.4 Cambodia

8.4.1 Dr Rosa Perez, Climate Change Specialist (Consultant) with the Asian Development Bank made a presentation on "Climate Services for Implementation of PPCR in Cambodia: Issues and challenges".

8.4.2 The Cambodia SPCR covers three sectors: agriculture, water resources and infrastructure with nine themes: climate risk management; flood and drought management; coastal resilience; disaster risk reduction; ecosystem-based adaptation; business-focused adaptation; climate proofing of infrastructure including water supply and sanitation, post-harvest facilities and roads; capacity strengthening for mainstreaming resilience into development planning; and stakeholder participation.

8.4.3 Key components of Cambodia SPCR that would benefit from enhanced climate services include

8.4.4 Component I on Promoting Climate-Resilience of Water Resources and Related Infrastructure covers water resources planning and management agenda; agricultural support services through preparedness to climate extreme events; increased capacity of relevant local government agencies on flood and drought forecasting and early warning; and capacity building for community-based disaster risk reduction and climate change adaptation.

8.4.5 Component II on Enhancing Climate-Resilient Agriculture and Food Security covers flood protection structures; increased water supply and improved water storage; mangrove and non-

mangrove species restoration as a means to protect communities from wind force, flooding due to sea level rise and storm and piloting of crop insurance scheme.

8.4.6 Component III on Improving Climate-Resilient Infrastructure focuses on manuals on operation for road maintenance; guidance to cope with impacts of extreme climate events; Capacity strengthening (national and sub-national agencies) to provide safe, cost-effective and climate risk resilient infrastructure; and raising awareness on environmental concerns and climate change.

8.4.7 Component IV on Cluster Technical Assistance for Strengthening Capacity to Mainstream Climate Resilience into Development Planning emphasizes establishment of PPCR Coordination and Technical backstopping unit at the Ministry of Environment; provision of support to civil society organizations to galvanize adaptation efforts at commune level; feasibility studies on high priority NAPA projects; information and knowledge products generation and dissemination throughout Cambodia, across the GMS and Southeast Asia; development of a knowledge management and learning platform on climate change adaptation; and support mechanism for civil society to promote mainstreaming climate resilience especially at commune and provincial levels.

8.4.8 There are a number of data and information gaps in Cambodia that need to be addressed. Accurate and reliable local forecasts of extreme climate events are non-existent. Meteorological information for Cambodia is sparse. There is a lack of comprehensive vulnerability maps identifying the locations of high vulnerability. The use of existing meteorological information is limited to specific agencies. Flood forecasting and communication systems are weak and should be improved in those areas that are heavily affected by floods. Growing demand for detailed accounts of local adaptation to climate change to serve as a starting point for knowledge exchange on successful practices among vulnerable populations and to support rational policymaking in vulnerable areas. Mechanisms for mainstreaming at the administrative level need to be developed. Differential effects of climate variability and change on disaster vulnerability, including shifting rainfall patterns and the impacts of a changing climate on crop yields under various management scenarios need to be studied.

8.4.9 Cambodia SPCR going to fill those gaps partly or fully through better observations, (installation of hydro-meteorological monitoring facilities; construction and upgrading of flood protection systems and early warning systems); knowledge products generation (Production of vulnerability maps, development of a knowledge management and learning platform in close collaboration with the EU-UNDP-SIDA-DANIDA funded Cambodia Climate Change Alliance);capacity building (use of climate information for informed decisions) and develop lessons and share good adaptation practices (construction and/or rehabilitation of agricultural post-harvest facilities to cope with both current and future impacts of climate change; mobilizing local associations and communities (CSOs, local water associations) for community-based DRR; deployment of water saving technologies in urban and peri-urban areas; involvement of different multi-stakeholders (NGAs, NGOs, CSOs and private sector).

8.4.10 The relationship between SPCSR and climate services is mutual. Initially, SPCR may need more inputs in terms of baseline information. In the long term, SPCR is expected to contribute to a more robust climate services in Cambodia.

9. Building Climate Services at the National Level

9.1 User Interface Platform

9.1.1. Dr Mannava Sivakumar, Consultant in the Climate Prediction and Adaptation Branch of WMO made a presentation on the “User Interface Platform”.

9.1.2 The User Interface Platform (UIP) is one of the pillars of GFCS and it bridges the gap between climate service providers and users of climate information. Many socio-economic sectors are highly sensitive to weather and climate extremes. Decision-makers in these sectors

are insufficiently equipped to make effective use of climate information in managing current and future climate risks as well as associated risks to ecosystems. Consequently, there is an urgent need for exchanging this information between the providers and users of climate services.

9.1.3 Recent advances in science and technology offer the prospect of further improvements in the quality of climate information and prediction services. The range, timing, quality and content of climate products and services needed across all socio-economic sectors need to be addressed to ensure that decisions relating to managing climate risks are well informed, more effective and better targeted.

9.1.4 A climate service is considered to be the provision of climate information in such a way as to assist decision-making by individuals and organisations. The service component involves appropriate engagement, an effective access mechanism and responsiveness to user-needs. Users and providers need to interact better. The user-driven focus of the Framework requires a much higher level of involvement of users in all aspects of climate service production, delivery and use.

9.1.5 UIP is a structured means for users, climate researchers and climate information providers to interact at all levels to improve the scientific quality, accessibility and relevance of climate information to users. UIP ensures that users are fully involved to establish the needs, develop appropriate products, identify capacity development requirements and influence the direction of observational investments and research efforts.

9.1.6 The objective of the User Interface Platform is to promote effective decision making with respect to climate considerations by making sure that the right information, at the right time and in the right amount, is delivered, understood, and used.

9.1.7 The UIP operates using a wide-range of methods designed to promote mutual understanding, including formally established committees, working groups, internship programmes, one-on-one discussion, workshops, conferences and inter-agency task teams. Communication, outreach and training approaches are equally wide-ranging. They include radio broadcasts, social media and public service announcements while using technologies such as map interfaces, portals and information servers. In many areas of this work there are opportunities to build upon dialogues already well-established or that are growing in effectiveness, such as the Regional Climate Outlook Forums, community liaison working groups in the disaster management community and national health working groups.

9.1.8 The proposed enhanced interaction between users and providers aims to reconcile the availability of credible climate information with the needs of users for information to support their decision making. This mutual understanding can then frame an end-to-end climate service that may involve developing useful products. Developing such products may hinge upon further research or new observations, so by facilitating this mutual understanding the UIP will inform the priorities of each of the other pillars. For example, it can highlight capacity requirements for delivering and supporting these products as a climate service. The Platform is not, therefore, a stand-alone entity; it functions instead as a liaison through which the other pillars of the Framework can generate and deliver what is needed for climate-sensitive decision making.

9.1.9 Examples of mechanisms for improving interactions with users at the national level are through integrating spatial data, tools and management, developing Enabling institutional networks and multi-agency interactive meetings to understand the user needs and prepare agro-advisories.

9.1.10 Examples of mechanisms for improving interactions with users at the local level are through farmer workshops, roving seminars.

9.2 Climate Services Information System, Observations and Monitoring, Research Modelling and Prediction

9.2.1 Dr Michael Coughlan, Consultant with WMO made a presentation on “Building Climate Services at the National Level: Climate Services Information System, Observations and Monitoring, Research Modelling and Prediction”.

9.2.2 The Observations and Monitoring pillar will support: the development and updates of national data bases on climate hazards to support early warning systems against extreme weather and climate events and their impacts; the provision of high resolution data sets with time resolution as low as daily – focusing on key variables, i.e. precipitation, temperature, relative humidity, evapotranspiration, snow water equivalent, soil moisture and vegetation indices.

9.2.3 The structure of observations and monitoring pillar is based on assessment, data collection and dataset development.

9.2.4 The initial implementation of the Observations and Monitoring pillar consists of seven projects ranging from establishment of formal mechanism for consultation with users to establishment of coordination mechanisms for collection, management, and exchange of climate and related food security data and for architecture for climate monitoring from space.

9.2.5 In the Climate Services Information System (CSIS), the linkages and respective data and information exchanges between climate observing systems, the various climate data centres, and the climate analysis, monitoring and prediction Centres are implicit. There is a central role to be played by the Regional Outlook Forums and their national counterparts in synthesizing and clarifying information fed by the CSIS entities through the various processes of the User Interface Platform, which will be more diverse and complex.

9.2.6 There is a hierarchy of climate services at the national level which includes: a basic range of climate data services and information products (Category 1); essential climate data services and information products (Category 2); a comprehensive range of climate data services and information products (Category 3) and provision of advanced climate services (Category 4).

9.2.7 The Research, Modelling and Prediction will: develop and improve practical applications and information products, especially in the four near-term priority areas; enhance the interaction and cooperation between climate information users and operators, and the corresponding research communities in collaboration with the User Interface Platform (UIP); improve the scientific base of climate projections, predictions, and user-tailored climate information products, and their readiness for operational implementation; and continue to improve understanding of those aspects of variability and change in the Earth’s climate that affect people, ecosystems, and infrastructure.

9.2.8 Considerable additional effort is generally required to bring the benefits of research, i.e. its results and outcomes, into an ‘operational’ climate service environment

9.3 Capacity Development

9.3.1 Mr Filipe Lucio, Head of the GFCS Office of WMO made a presentation on “Capacity Development of the Global Framework for Climate Services (GFCS)”.

9.3.2 The objective of GFCS Capacity Development is to facilitate the provision of improved climate services to those people who need it. The areas of focus are specific capacity development requirements identified in the other four pillars of GFCS; and more broadly the basic requirements (national policies/ legislation, institutions, infrastructure and personnel) to enable any GFCS related activities to occur.

9.3.3 The capacity development needs cover: Human resource capacity (individuals with the knowledge, skills and training to able to generate, communicate and use decision-relevant climate information); Infrastructural capacity (to implement infrastructure to generate, archive, quality control, communicate, exchange and use climate data and decision-relevant information

and products on the supply side, instruments for observing networks, data management systems, computer hardware and software, internet access, communication tools, manuals and scientific literature On the demand side but potentially much more diverse similar capabilities); Procedural capacity – defining, implementing and advancing best practices for generating and using climate information); Institutional capacity –processes, policies and procedures that enable effective climate services, not only within organizations but also in managing relationships between the different organizations and sectors (public, private and community, including international collaboration) with similar requirements on the demand side but once again more diverse.

9.3.4 Essential climate related capabilities of NMHSs include: Observations (data management with quality assurance (archives & rescue), climate standards (i.e. those of GCOS), historical & real-time observations of the Essential Climate Variables, contribute data to WIS and improve station density); Research (participate in field experiments and applied research, develop new products); Operations (generation of climate information and prediction products (including GPC/RCC/RCOF linkages), tailoring/downscaling, dissemination/communication); Capacity Development (participate in/organize training activities, participate in Regional Climate Outlook Forums); User interface (interact with user to meet requests and improve products, contribute to Regional Climate Outlook Forums, coordinate National Climate Outlook Forums).

9.3.5 There are a number of priorities, including resource mobilization to ensure improved capacity development for GFCS.

10. Operating Climate Services at the National Level

10.1 Observations, Monitoring, Analysis and Prediction

10.1.1 Dr Michael Coughlan, Consultant with WMO made a presentation on “Operating Climate Services at the National Level: Observations, Monitoring, Analysis and Prediction”

10.1.2 The presentation stressed the need to put in place mechanisms to ensure that the climate information and prediction needs of all users and potential users are known. Once user needs are known, it is critical that retrieval and collection of meteorological and related observations, management of data bases, and the provision of data is ensured. Observations are critical so as to enable better understanding of the climate system, since “unless one can measure something, one can not manage it”.

10.1.3 In responding to user needs, coordination of meteorological, oceanographic, hydrological, and related scientific research to improve climate services is particularly critical. In addition, multidisciplinary studies to determine national risk, sectoral, and community vulnerability related to climate variability and change, to formulate appropriate response strategies, and to recommend national policies is critical. Therefore, developing a national climate observing system will require effective collaborative mechanisms.

10.1.4 From the operational point of view, development and operational provision of climate information and prediction services to meet user needs is essential. This should be done through linkages to other programmes with similar or related objectives to avoid unnecessary duplication of efforts.

10.1.5 Concrete examples of use of climate services and development of specific tools such as database management system, national climate watch, and a case study on success on capacity development in Vanuatu, were presented.

10.2 Data Archiving and Data Services

10.2.1 Dr Mannava Sivakumar, Consultant in the Climate Prediction and Adaptation Branch of WMO made a presentation on the “Data Archiving and Data Services”.

10.2.2 In some countries climate data may also be collected by organisations whose activities are especially sensitive to climate and hence have requirements that are better served through the establishment of their own networks of observing stations. Such entities could include agricultural enterprises, energy producers, air quality authorities, water managers and natural resource developers. Given this, all countries should strive to identify such data sources and where possible ensure that the records become part of the national climate archive. All organisations collecting climate and related data for whatever purpose should be informed of the importance of adhering to standards of accuracy and continuity.

10.2.3 A national climate database is a critical piece of infrastructure that can be drawn on for a very wide range of applications. Therefore, countries should seek to invest in a relational climate database management system, the complexities and capabilities of which should be matched to the national requirements for climate services. The chief general requirements for climate data in supporting most climate services and applications are that they be reliable, quality controlled, accessible, as far as possible complete, and long-term.

10.2.4 Data should generally be made freely available or at the cost of providing them to other national users, although it is accepted that special conditions for provision and use may be applied, especially where data are to be used within a commercial context

10.2.5 Examples of data rescue initiatives such as the DARE projects in Africa, Southern America and Caribbean covering surface, upper air and strip charts data. The meeting recognized the need for Modern Data Archiving and Management Systems.

11. Breakout Group Sessions

11.1 Dr Mannava Sivakumar, Consultant in the Climate Prediction and Adaptation Branch of WMO made a presentation on the “Discussion on Breakout Groups and Terms of Reference”.

11.2 He discussed the specific objectives of the workshop and the purpose of breakout group discussions.

11.3 The purpose of the breakout group sessions is to: Identify the major areas of improvement required between climate service providers and users in Asian LDCs; articulate the capacity building needs of LDCs for climate services in different sectors; and propose ways to promote community understanding of climate variability and change along with associated risks and opportunities for improved climate risk management and raise user awareness of climate products and services.

11.4 Two breakout groups were established: (1) Group I: Early Warning Systems and Capacity Building for Climate Services in the LDCs: Needs and Priorities; (2) Group II: Climate Risk Management and Raising User Awareness in the LDCs

11.5 Terms of reference of Group I are: (1) Identify 5-6 major areas of improvements for better interactions between climate service providers and users; and (2) Enumerate the capacity building needs of LDCs for climate services in different sectors so that a comprehensive package of capacity building can be developed.

11.6 Terms of reference of Group II are: (1) Identify one key climate risk management strategy for a key sector in your country around which a pilot project can be developed and implemented for a two year period (2013-2014) to demonstrate the economic benefit that can be derived; and (2) As part of this pilot project, include essential activities that will be undertaken to raise user awareness.

12. Summaries of Breakout Group Reports

12.1 Group I: Early Warning Systems and Capacity Building for Climate Services in the LDCs: Needs and Priorities

12.1.1 Major areas of improvements for better interactions between climate service providers and users:

a) The need for formal mechanisms to co-ordinate both between suppliers and users of climate services; and across sectoral agencies and institutions within specific countries, where there can be up to 15 or more agencies involved, through well-defined and well-organized activities such as workshops and forums; and through web-based activities.
b) Building user capacity to make beneficial use of climate services; including the capacity of CS providers to understand the specific needs of the end users and the forms that CS must take to be useful.
c) Mapping of country-specific capacity development needs, linked to development plans as a first step required to inform the capacity development process and prioritize capacity development activities; this also links to and enables donor harmonization.
d) Line ministry co-ordination and data sharing; standards for the collection, management, documentation and reporting of climate information.
e) Sector-specific projections and forecasts tailored climate services ("climate services").

12.1.2 Capacity building needs of LDCs for climate services in different sectors:

a) Build capacities in modeling, downscaling climate (statistical, dynamic), hydrology, other sectors; more generally in building research capacity in climate and closely linked sectors.
b) Improve the capacity of media (radio, TV, internet, etc.) who perform an essential role in the dissemination of climate information, to understand and interpret climate information, including the needs of specific sectors and regions.
c) Need to strengthen observations and data collection systems – "silent" stations, timeliness of reporting and etc.
d) Improve the visibility of the meteo services so that there is a more clear and consistent presentation of the issues – e.g., local focal points.
e) Create incentives for those who receive advanced training to remain in their respective countries/communities (avoiding "brain drain").
f) Prioritization of support for climate services, provider organizations in national legislation and policy frameworks; sensitization of national policy-makers to the growing importance of CS.
g) Emphasize the need to present investments in climate capacity (capacity to develop and deliver services) not as a "cost" but as an investment with a payoff.
h) In capacity building, don't forget the private sector, including broadcast media.
i) Capacity building for disaster risk management, including role of the media and community-level institutions and organization.

12.2 Group II: Climate Risk Management and Raising User Awareness in the LDCs

12.2.1 Key climate risk management strategy for a key sector in each country and essential activities that will be undertaken to raise user awareness

a) Bangladesh: Early warning system for flood management in Northeast Bangladesh

- Installation of rain gauges in the Indian part, and sending information to Bangladesh;
- Real time data transmission between two countries;

- Transboundary information sharing between Indian and Bangladesh;
- User-friendly climate information and knowledge exchange;
- Target stakeholders: Religious leaders; District/Sub-district officials; Farmers.

b) Nepal: Early warning system for droughts in Far-Western Development Region

- Development of national drought policy;
- Installing rain gauges and other related hardware;
- Raising awareness of farmers through roving seminars/Farmer field schools;
- Secondment of early warning system experts;
- Communication through mass media;
- Target stakeholders: Religious leaders; District/Sub-district officials; Farmers.

c) Cambodia: Drought risk management in Svay Rieng Province

- Improved data sharing among government agencies;
- Installation of Micro-meteorological station;
- Production and dissemination of agro-climatic information;
- Capacity building for crop simulation through FAO Agricultural model inter-comparison project in Rome and Bangkok;
- Target stakeholders: Private sector; District and commune officials; Farmers.

d) Lao PDR: Flood risk management in Khamoune province in Central Lao PDR

- Installation of Data loggers (at least 3 weather stations);
- Identification of adaptation options for rice production;
- Capacity building on seasonal flood forecasting;
- Raising farmer awareness through national climate outlook and Farmer Field Schools;
- Target stakeholders: Private sector; District officials; Farmer organizations.

e) Maldives: Climate forecasting for improved water security in a selected group of islands

- Installation of additional rain gauges;
- Capacity building for climate forecasting;
- Raising awareness on options for enhanced water security (drinking water);
- Additional data collection;
- Target stakeholders: Island communities; Atoll councils; Local councils.

f) Bhutan: Assessment of snow pack and glacier monitoring in LUNANA

- Installation of 5 new snow gauge stations;
- Upgrading of glacier monitoring stations;
- Mapping of snow pack;
- Information sharing using modern communication systems (e.g. SMS);
- Target stakeholders: Local government officials; Scientists.

g) Vanuatu: Effective use of climate information for enhanced root tuber production in a selected island

- Capacity building for crop simulation for yield prediction and assessment of alternate options;
- Raising awareness of farmers through Climate field schools;
- Dissemination of information to farmers;
- Additional data collection on traditional knowledge (coping mechanisms, adaptation options);
- Target stakeholders: Department of agriculture officials and researchers; Farmers.

h) Samoa: Early warning system for droughts in Samoa

- Capacity building for GIS and other spatial information technologies;
- Development of national drought policy and drought index;
- Raising awareness of farmers;
- Dissemination of real time information to farmers;
- Additional data collection on traditional knowledge (coping mechanisms, adaptation options);
- Target stakeholders: Department of agriculture officials and researchers; Samoa Farmers' Association; School of agriculture of the University of South Pacific; National University of Samoa; Scientific research organizations of Samoa.

j) **Myanmar: Early warning system for tropical storms in Rakhine coast**

- Upgrading radar stations;
- Training and capacity building for modeling;
- Raising awareness of local officials on storm response options;
- Dissemination of real time information to users including media;
- Target stakeholders: Local officials; Media; Local communities including farmers, fishermen and other rural people.

13. Closing of the Workshop

On behalf of the organizers of the workshop, Mr Filipe Lucio, Head of GFCS Office in WMO, thanked all the participants for their active participation and constructive outcomes.

Annex 1

Regional Workshop on Climate Services at the National Level for the Least Developed Countries in Asia

Bangkok, Thailand, 8-10 October 2012

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Annex 2

Regional Workshop on Climate Services at the National Level for the Least Developed Countries in Asia

PROGRAMME

The World Climate Conference-3 held in 2009 decided to establish a Global Framework for Climate Services (GFCS), an international framework to guide the development of climate services. The vision of the GFCS is to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to such risks. This will be done through development and incorporation of science-based climate information and prediction into planning, policy and practice. The greatest value of the GFCS will occur incrementally through the delivery of a multitude of climate services at national or local levels. Climate-sensitive developing countries stand to gain the most from better climate information but are often precisely where climate services are weakest. The Framework will give priority to capacity building in these countries.

SPECIFIC OBJECTIVES OF THE WORKSHOP

- To review the current status of generating climate information in the LDCs in Asia and assess their needs for climate services in the agriculture, food security and water user sectors at the national and local levels;

- To assess the current status of interactions of the climate service providers with the users in the priority sectors and identify the major areas for improvement;

- To discuss and recommend improved arrangements for national observation networks, enhanced research focus on national and local climate problems, better access to climate predictions, sustained operational mechanisms that facilitate the flow of climate information from global and regional scales through the national and local scales, and effective user interface mechanisms at the national scale;

- To articulate the capacity building needs of LDCs, in terms of mandates, infrastructure as well as human resources, in all the components of the GFCS;

- To identify and propose ways to promote community understanding of climate variability and change along with the associated risks and opportunities for improved climate risk management and raise user awareness of climate products and services.

SUNDAY, 7 OCTOBER 2012

Participants arrive in Bangkok, Thailand

MONDAY, 8 OCTOBER 2012

SESSION 1: OPENING OF THE MEETING

09:00 hrs **Welcome**
Somchai Baimoung
Acting Director-General
Thailand Meteorological Department

09:10 hrs **Address**
Filipe Lucio
Head, GFCS Office
World Meteorological Organization (WMO), Switzerland

09:20 hrs **Address**
Winfried Wicklein
Principal Country Economist, Thailand Resident Mission
Asian Development Bank

09:30 hrs **Opening of the Meeting**
Man Ho So
Deputy Regional Representative
FAO Regional Office for Asia and the Pacific

09:45 hrs **Group Photo and Tea/Coffee Break**

SESSION 2: LDCs AND CLIMATE SERVICES

(CHAIRMAN: CHARLES RODGERS)

10:15 hrs **The WMO Programme for LDCs and the Istanbul Programme of Action**
Datius Rutashobya,
World Meteorological Organization (WMO), Switzerland

10:45 hrs **Global Framework for Climate Services**
Filipe Lucio
World Meteorological Organization (WMO), Switzerland

11:15 hrs **Discussion**

SESSION 3: CURRENT STATUS OF CLIMATE SERVICES IN THE LDCs OF ASIA

(CHAIRMAN: MIKE COUGHLAN)

11:30 hrs **Nepal**
Rishi Ram Sharma
Department of Meteorology and Hydrology, Nepal

11:45 hrs **Bhutan**
Karma Tsering
Department of Hydrological and Meteorological
Services, Bhutan

12:00 hrs **Lao PDR**

Souvanny Phonevilay
Department of Meteorology and Hydrology, Lao PDR

12:15 hrs **Discussion**

12:30 hrs **Lunch**

SESSION 3: CURRENT STATUS OF CLIMATE SERVICES IN THE LDCs OF ASIA (contd.)

(CHAIRMAN: (BEAU DAMEN)

13:30 hrs **Myanmar**
Tin Mar Htay
Department of Meteorology and Hydrology, Myanmar

13:45 hrs Bangladesh
Saiful Islam Khan
Bangladesh Meteorological Department

14:00 hrs **Samoa**
Sunny Seuseu
Meteorology Division, Ministry of Natural Resources and Environment, Samoa

14:15 hrs **Discussion**

14:30 hrs **Soloman Islands**
David Hiriasia
Solomon Islands Meteorological Service

14:45 hrs **Kiribati**
Kien Teteki
Kiribati Meteorological Service

15:00 hrs **Vanuatu**
Nihmei Kaniaha Salesa
Meteorological and Geohazards Department, Vanuatu

15:15 hrs **Maldives**
Zahid Hameed
Maldives Meteorological Service, Maldives

15:30 hrs **Tea/Coffee Break**

16:00 hrs **Discussion**

16:30 hrs **Adjournment**

19:00 hrs **Workshop Dinner**

TUESDAY, 9 OCTOBER 2012

SESSION 4: NEEDS FOR CLIMATE SERVICES, CURRENT STATUS AND COMMUNICATION OF CLIMATE INFORMATION TO USERS IN THE AGRICULTURE SECTOR

(CHAIRMAN: ANCHA SRINIVASAN)

08:30 hrs **Bangladesh**
Ansar Ali
Ministry of Agriculture, Bangladesh

08:45 hrs **Cambodia**
Pheav Sovuthy
Ministry of Agriculture Forestry and Fisheries, Cambodia

09:00 hrs **Lao PDR**
Thavone Inthavong
National Agriculture and Forestry Research Institute (NAFRI), Lao PDR

09:15 hrs **Importance of climate services for agriculture**
Beau Damen
FAO Regional Office for Asia and Pacific, Thailand

09:30 hrs **Managing climate shocks to agriculture through early warning systems**
Subbiah Arjunapermal
Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

09:45 hrs **Needs for Climate Services, Current Status and Communication of Climate Information to Users in the Agriculture Sector**
Pramod Aggarwal / Michael Sheinkman
CGIAR Research Program on Climate Change, Agriculture and Food Security

10:00 hrs **Discussion**

10:30 hrs **Tea/Coffee Break**

SESSION 5: NEEDS FOR CLIMATE SERVICES, CURRENT STATUS AND COMMUNICATION OF CLIMATE INFORMATION TO USERS IN THE WATER SECTOR

(CHAIRMAN: RISHI RAM SHARMA)

11:00 hrs **Bhutan**
Gongsar Karma Chhopel
National Environment Commission, Bhutan

11:15 hrs **Bangladesh**
Md. Mosaddeque Hossain
Bangladesh Water Development Board, Bangladesh

11:30 hrs **Cambodia**
Peo Phalla
Ministry of Water Resources and Meteorology,

Cambodia

11:45 hrs **Climate Services for Effective Water Resources Management in the Asian LDCs**
Charles Rodgers
Asian Development Bank, Philippines

12:15 hrs **Discussion**

12:30 hrs **Lunch**

SESSION 6: NEEDS FOR CLIMATE SERVICES, CURRENT STATUS AND COMMUNICATION OF CLIMATE INFORMATION TO USERS IN THE HEALTH AND DISASTER RISK REDUCTION SECTOR

(CHAIRMAN: NIHMEI KANIAHA SALESA)

13:30 hrs **Perspectives from WHO on the Needs for Climate Services in the Health Sector of LDCs in Asia**
Khalil Rahman
WHO Liaison Office with UNESCAP, Thailand

13:45 hrs **Needs for Climate Services in the DRR Sector of LDCs in Asia**
Arghya Sinha Roy
Asian Development Bank, Philippines

14:00 hrs **Climate services in the DRR sector in Cambodia and Lao PDR**
Senaka Basnayake
Asian Disaster Preparedness Centre, Thailand

14:15 hrs **Maldives**
Afsal Hussain
Ministry of Environment and Energy, Maldives

14:30 hrs **Nepal**
Jay Ram Adhikari
Ministry of Environment, Science and Technology
Nepal

14:45 hrs **Needs for Climate Services in the DRR Sector from Local Communities' Perspective**
Indira Kulenovic
International Federation of Red Cross and Red Crescent Societies
South-East Asia Regional Delegation, Thailand

15:00 hrs **Discussion**

15:30hrs **Tea/Coffee Break**

SESSION 7: CLIMATE RISK MANAGEMENT IN ASIAN LDCs: SOME INSIGHTS FROM PILOT PROGRAM FOR CLIMATE RESILIENCE (PPCR)

(CHAIRMAN: MANNAVA SIVAKUMAR)

16:00 hrs **Climate Services for Effective Implementation of PPCR: An Overview**
Ancha Srinivasan
Asian Development Bank, Philippines

16:15 hrs **Bangladesh**
Arif Faisal
Asian Development Bank, Bangladesh

16:30 hrs **Nepal**
Rishi Ram Sharma
Department of Meteorology and Hydrology, Nepal

16:45 hrs **Cambodia**
Rosa Perez
Consultant, Asian Development Bank

17:00 hrs **Discussion**

17:30 hrs **Adjournment**

WEDNESDAY, 10 OCTOBER 2012

SESSION 8: BUILDING CLIMATE SERVICES AT THE NATIONAL LEVEL

(CHAIRMAN: DATIUS RUTASHOBYA)

08:30 hrs **User Interface Platform**
Mannava Sivakumar

08:45 hrs **Climate Services Information System, Observations and Monitoring, Research Modelling and Prediction**
Michael Coughlan

09:15 hrs **Capacity Development**
Filipe Lucio

09:30 hrs **Discussion**

10:00 hrs **Tea/Coffee Break**

SESSION 9: OPERATING CLIMATE SERVICES AT THE NATIONAL LEVEL

(CHAIRMAN: FILIPE LUCIO)

10:30 hrs **Observations, Monitoring, Analysis and Prediction**
Michael Coughlan

11:00 hrs **Data Archiving and Data Services**
Mannava Sivakumar

11:30 hrs **Discussion**

12:00 hrs **Lunch**

SESSION 10: BREAKOUT SESSIONS

13:00 hrs **Discussion on breakout groups and terms of reference**
Mannava Sivakumar

13:15 hrs **Meetings of breakout groups**
Group I: Early Warning Systems and Capacity Building for Climate Services in the LDCs: Needs and Priorities

Group II: Climate Risk Management and Raising User Awareness in the LDCs

15:30 hrs **Tea/Coffee Break**

SESSION 11: PLENARY TO CONSIDER BREAKOUT GROUP REPORTS

(CHAIRMAN: ANCHA SRINIVASAN)

16:00 hrs **Group I**

16:30 hrs **Group II**

SESSION 12: CLOSING SESSION

17:00 hrs **Word of thanks on behalf of the organizers and Workshop Closure**
Filipe Lucio
World Meteorological Organization (WMO), Switzerland
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