National Climate Outlook Forum (NCOF) and National Stakeholder Consultation (NSC) on Climate Services in Bhutan

19- 21 October 2015

Thimphu, Bhutan

REPORT

Department of Hydro Met Services
Ministry of Economic Affairs
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Executive Summary

The National Climate Outlook Forum (NCOF) and National Stakeholder Consultation (NSC) on Climate Services were hosted by the Department of Hydro Met Services (DHMS), Ministry of Economic Affairs, Bhutan and the World Meteorological Organization (WMO) and held at Thimphu, Bhutan 19-21 October 2015. Participants in the events included a wide-ranging representation of partners and stakeholders from the water, disaster risk management, health, agriculture, and energy sectors, among others.

The NCOF and NSC addressed the implementation and delivery of climate services at the national level, including an overview of the Global Framework for Climate Services (GFCS) as it relates to the national context; climate services successes, needs, gaps and challenges; and the existing institutional framework for climate services in Bhutan. The NCOF, an operational activity, set the stage for a regular dialogue between the provider of seasonal climate information, DHMS, and sectoral users of climate information in Bhutan. The NSC brought together representatives from the GFCS Office, WMO, Indian Meteorological Department (IMD), Regional Integrated Multi-hazard Early Warning System (RIMES), the Finnish Meteorological Institute (FMI), World Bank, United Nation Development Program (UNDP) and relevant national sectoral stakeholders.

NCOF-1 and NSC in Bhutan were supported by the *Programme for Implementing the GFCS at Regional and National Scales*, funded by Environment and Climate Change Canada. Collateral support was also provided by the project *Strengthening Hydro-Meteorological Services for Bhutan,* funded by the Ministry of Foreign Affairs Finland.

Recommendations

NCOF -1 and NSC provided a series of recommendations to enhance the provision of climate information and services in Bhutan. NCOF-1 recommended that the NCOF mechanism be institutionalized in a sustainable fashion, and that an annual NCOF be held prior to the summer monsoon and immediately after SASCOF. The NSC addressed the implementation of the National Framework for Climate Services (NFCS) in Bhutan and resulted in the development by NSC participants of sector-specific project proposals outlining service requirements for the agriculture, energy, disaster risk reduction and health sectors (ref: proposals provided on pp 12-18); capacity gaps and requirements associated with the provision and use of climate services were also

presented, and means of addressing these gaps explored. Given the lack of historic climate data for Bhutan, both NCOF-1 and NSC recommended that Bhutan and its partners explore various possibilities to reconstruct historic data in Bhutan.

Contents

Introduction

Geography, socio-economic landscape, and requirement for climate services

Bhutan is a landlocked, mountainous country situated in the eastern Himalayas, sandwiched between two giant countries: China in the north and India in the south. The country's topography is rugged and the altitude ranges from 100 m.a.s.l. in the south to over 7,500 m.a.s.l. in the north. Due to its complex terrain, Bhutan is highly vulnerable to hydro-meteorological hazards including glacial lake outburst floods (GLOFs), flash floods, riverine floods, landslide dam outburst floods, cloudbursts, windstorms, and river erosion. The river valleys, being fertile and suitable for farming, are home to most of the Bhutanese population; thus, a large percentage of the population is vulnerable to flooding hazards. Landslides and floods occur frequently in in Bhutan during the monsoon season (June to September).

Climate services are required by multiple sectors in Bhutan including agriculture, disaster risk reduction, and hydropower. Agriculture is the main occupation in Bhutan, engaging more than 70% of the country's population. The change in the climate pattern poses great challenges and risks to Bhutan's food security, and stakeholders in the agriculture sector require a range of climate services in order to make informed decisions. The increase in global temperature that is linked to climate change has introduced the threat of retreating glaciers in the Himalayas. In tandem with the increase in the volume of the glacier lakes, the risk of GLOFs has increased, along with the requirements of the disaster risk reduction sector for accurate and timely climate information and services. Hydropower is the main contributor to Bhutan's GDP, and the Royal Government of Bhutan aims to generate 10 000 MW by the year 2020. Monsoon rain contributes more than 70% of Bhutan's annual rainfall during summer, and the rivers' streamflow derives mainly from precipitation. However, during the winter, when the climate in Bhutan is dry and cold, river discharge relies on the glacial melt flow, and is typically reduced. Therefore, to plan its hydropower generation throughout the year, Bhutan requires seasonal to decadal climate projections.

With continuing changes in the climate, the frequency and intensity of extreme events in Bhutan, as elsewhere, are expected to increase. Heavy rainfalls from cyclones originating from the Bay of Bengal, and wind storms during the pre- and post-monsoon season also contribute to the loss of property and lives. In

May 2009, Cyclone Aila affected Bhutan: three days of persistent heavy rainfall caused flash floods and landslides throughout the country. On 4 and 17 April 2015, windstorms affected more than 800 households, mostly in the southern belt of Bhutan. Thus, climate risk management is a prime concern of DHMS.

In contrast, opportunities presented by climate change in Bhutan include the generation of hydropower, and further development of the agriculture sector. Heavy rainfall contributes to river flow which, in return, provides the opportunity to effectively generate electricity via hydropower. Seasonal winds, both pre-monsoon and post monsoon, can be further studied to assess the potential of wind energy generation. Increased access to reliable climate services such as seasonal forecasts and agromet advisories will immensely help the agriculture sector in planning and preparing for seasonal crops.

Access to critical climate products and services, and effective communication of information on climate variability (including extremes) and long-term climate change will support attainment of "self-reliance and inclusive green socio-economic development in Bhutan". These essential climate products and services can help manage, prevent and reduce economic losses caused by disasters that affect the wellbeing of Bhutan's society. Timely climate information is crucial for decision- and policy-making: for planning national development, managing development opportunities and risk, and identifying means of mitigation and adaptation. The DHMS serves as the "National Center for Weather, Climate and Water Resources" and is mandated with providing hydro-meteorological products and services to support policy, planning and decision-making. The functions of DHMS are thus closely linked to the provision of and use of climate information. To ensure that climate information is integrated into the decision- and policymaking process by climate sensitive sectors, the DHMS must interpret climate data and tailor information products to address the needs and requirements of the stakeholders and users from climate sensitive sectors in Bhutan.

Climate policy landscape in Bhutan: Recent national policies related to climate services

Gross National Happiness Policy Screening Tool, 2009

The Gross National Happiness (GNH) Policy Screening is a tool used to assess the impact of new policies on GNH and to mainstream GNH into all new policies in the Kingdom of Bhutan. Since its introduction, twelve policies

related to human resources, youth, education, health and nutrition, land, natural resources, and industries have been approved (Gross National Happiness Commission, 2013).

Economic Development Policy, 2010

The Economic Development Policy (EDP) aims to enhance the productive capacity of the economy and to provide a strategic direction for economic development up to 2020. With a vision to promote a green and self-reliant economy, the EDP's stated objectives are to achieve economic self-reliance and full employment (97.5 percent) by 2020. The strategies set out to achieve the objectives include diversification of the economic base with minimal ecological footprint, harnessing and value addition to natural resources in a sustainable manner, increasing and diversification of exports, promoting Bhutan as an organic brand, promoting industries that build "Brand Bhutan"10 and reducing dependency on fossil fuel especially for transportation (Gross National Happiness Commission, 2013).

National Forest Policy, 2010

The National Forest Policy recognizes the importance of the sustainable management of forests for sustainable production of economic and environmental goods and services for socio-economic benefits and poverty reduction. The policy recognizes both science-based and cultural values for forest governance and management including integration of climate change, disaster management and payment of environment services (Royal Government of Bhutan, 2010).

Renewable Natural Resource Research Policy, 2011

The Renewable Natural Resource (RNR) Research Policy provides a long-term framework for decisive action to ensure that research is relevant to clients' needs, problem-oriented and those research methods, research programmes, research administration, and research financing and resources sharing mechanisms are systematically and collaboratively coordinated, implemented, monitored and evaluated (Royal Government of Bhutan, 2011).

Alternate Renewable Energy Policy, 2013

The Alternate Renewable Energy Policy intends to provide the necessary direction for the promotion and development of renewable energy that not only contribute in meeting the current energy requirements but also shape future energy security options for the Nation. The Policy aims to contribute to the sustainable development, climate change mitigation, energy and economic

security, and conservation of environment in the Kingdom of Bhutan (Royal Government of Bhutan, 2013).

Sector specific policies

Policy	Actions related to climate services
HEALTH	
National Health Policy, 2011	Prediction, preparedness and mitigation measures to address adverse effects of climate change on health shall be put in place through comprehensive multi-sectoral plan/emergency preparedness and public education on behavioral adaptations.
AGRICULTURE AND FOOD SECURITY	
Food and Nutrition Security Policy, 2012	Sustain conducive and stable environment for availability, accessibility and utilization of food by developing and implementing adaptation and mitigation measures for longer term climate and environmental changes, through the following actions: - Mainstream climate change adaptation and mitigation measure in food and security programs by identification and targeting vulnerable areas and communities. - Promote climate smart agriculture and farming practices.
WATER	
Bhutan Water Policy, 2003	Focuses on conservation of water resources by adopting appropriate technologies and integrated water resources management.
ENERGY	
Bhutan Sustainable Hydropower Development Policy, 2008	Contributes towards the development of clean energy to mitigate problem related to global warming and climate change.

Global Framework for Climate Services in Bhutan

Bhutan became acquainted with the GFCS when it hosted the WMO Workshop on the Implementation of Weather- and Climate- Related Services in Least Developed Countries (LDC) in Thimphu from 9 to 11 September 2014. The WMO team was led by Mr. Kuniyuki Shida, Sr. Programme Manager for Regional Coordination, Development and Regional Activities (DRA)

Department. Asian LDCs present at the workshop included South East Asia were Afghanistan, Bangladesh, Bhutan, Cambodia, Lao, Myanmar, Nepal and Yemen.

The Workshop addressed the relevance of weather- and climate-related services to the socio-economic development of LDCs, particularly in the priority areas of action of the Istanbul Programme of Action (IPoA), including the sectors of agriculture, food security and rural development, climate change, and disaster risk reduction. The Workshop also served as a forum for the Asian LDCs to share good practices and experiences regarding the application of meteorological and climatological information, products and services to strengthen socio-economic development. The workshop drafted recommendations for strengthening National Meteorological and Hydrological Services (NMHSs) of LDCs in Asia through the implementation of WMO programmes at national and regional levels.

Following the September 2014 Workshop, the Permanent Representative of Bhutan to WMO requested technical assistance from WMO in order to implement GFCS at the national level in Bhutan. The First Session of the National Climate Outlook Forum (NCOF-1) and National Stakeholder Consultation (NSC) on Climate Services in Bhutan were held at Thimphu, Bhutan, from 19 to 21 October 2015, with the technical support of WMO and regional experts from Indian Meteorological Department (IMD), Regional Integrated Multi Hazard and Early Warning System (RIMES).

NCOF-1 and NSC in Bhutan were supported by the *Programme for Implementing the GFCS at Regional and National Scales*, funded by Environment Canada. Collateral support was also provided by the project *Strengthening Hydro-Meteorological Services for Bhutan*, funded by the Ministry of Foreign Affairs Finland.

The WMO delegation was led by Dr. Maxx Dilley, Director, Climate Prediction and Adaptation Branch, Climate and Water Department, World Meteorological Organization. Staff members of DHMS and stakeholders from Bhutanese priority sectors including agriculture, health, disaster risk reduction, water and energy attended NCOF-1 and NSC.

First National Climate Outlook Forum (NCOF-1)

NCOF-1, an operational activity, set the stage for a regular dialogue between the provider of seasonal climate information, the DHMS, and users of climate information in Bhutan. The DHMS presented various services provided and the future plans for enhancing the services.

Objectives

The main objectives of NCOF-1 were as follows:

1) to provide climate information at relevant timescales through a regular and sustained multi-stakeholder dialogue process;
2) to ensure that climate information and products, including their uncertainties and limitations, are understood by and communicated to users;
3) to review the current status of the climate in Bhutan, and to share with participants the climate outlook information pertinent to climate risk management, resilience and adaptation needs;
4) to discuss users' views on how to make the climate information accessible, user-friendly and relevant; in order to maximize the benefit derived by end-users from climate prediction and information services;
5) to develop a culture of collaboration through joint climate-information interpretation sessions to better manage risks in climate-sensitive sectors; and
6) to improve the development and delivery of climate information, and to develop new climate information products and services that will contribute to the protection of natural resources, lives, livelihoods and property.

Climate outlook techniques

The seasonal experts from RIMES and GFCS Office/Beijing Climate Centre (BCC) outlined techniques of preparing climate outlooks and discussed the need to communicate and interpret seasonal uncertainties. The Expert from BCC presented a tool developed by the China Meteorological Administration (CMA), the Forecast System on Dynamic and Analogy Skills (FODAS), and indicated that CMA would be pleased to offer training to members of DHMS on the FODAS tool.

Climate outlook for Bhutan, Winter 2015

NCOF-1 reviewed the consensus climate outlook for winter 2015 that had been issued at the Seventh Session of the South Asian Climate Outlook Forum (SASCOF-7) held immediately prior to NCOF-1 in Chennai, India (Figure 1).
The Statistics Officer, DHMS, who had attended SASCOF-7, presented the climate outlook for Bhutan for winter 2015 based on the SASCOF-7 forecast (OND 2015) that predicted normal rainfall and above normal temperature. Based on a probabilistic multi-model ensemble forecast (NDJ 2015/16) the precipitation was predicted below normal

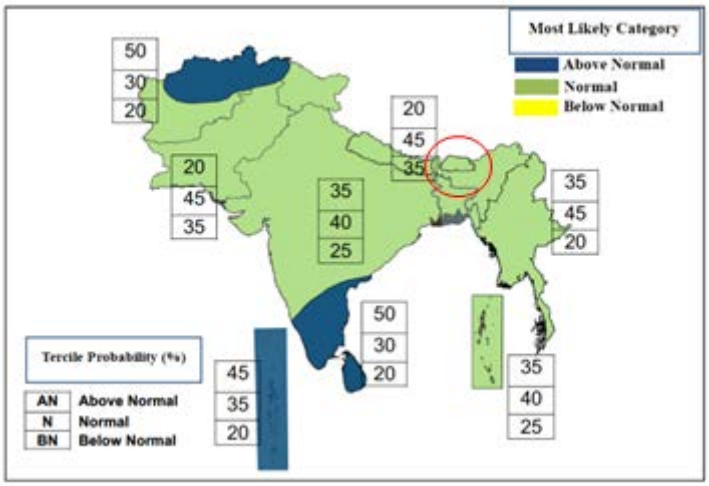

Figure 1: *Rainfall consensus outlook for October-November-December 2015 in the SASCOF domain*

The consensus outlook (Figure 1) and the probabilistic multi-model ensemble forecast (Figure 2) produced by the WMO Lead Center for Long-Range Forecast Multi-Model Ensemble (LC-LRFMME) provide information on rainfall forecast in the South Asian region. This information at a large scale enables the provision of information on the forecast at a smaller scale.

Figure 1 depicts normal rainfall in Bhutan, whereas Figure 2 depicts below normal precipitation over Bhutan during the 2015-2016 winter.

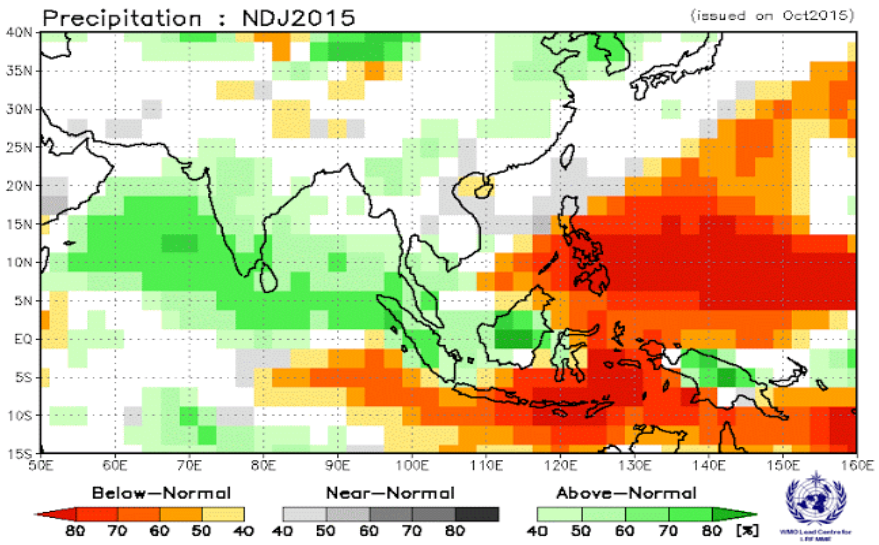

Figure 2: *Rainfall probabilistic multi-model ensemble forecast for 2015-2016 winter*

The DHMS Statistics Officer also presented seasonal climate forecasts (Figure 3 and Figure 4) produced by the Climate Predictability Tool (CPT) developed by the International Research Institute for Climate and Society (IRI). The seasonal climate forecasts had been generated by using a statistical approach to relate seasonal climate to changes in sea surface temperatures.

Figure 3 and Figure 4 show downscaled seasonal forecasts at the scale of the country, contrary to Figure 2 that presents rainfall forecasts at a large scale.

Figure 3 presents the rainfall forecast for October-November-December-January-February. Normal precipitation was predicted for the 2015-2016 winter in Bhutan.

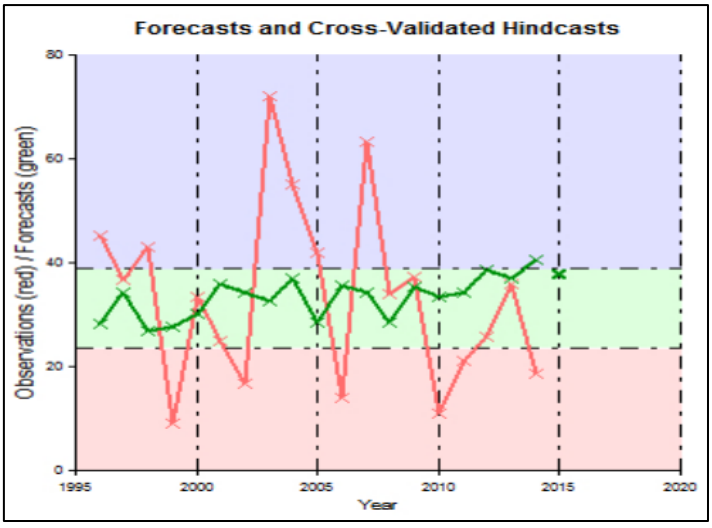

Figure 3: *Precipitation forecasts and cross-validated hindcasts for a given station. The observed precipitation is represented by the red curve, while the green curve stands for the forecasted precipitation. The purple area corresponds to above*

normal precipitation, the green area stands for normal precipitation and the red are corresponds to below normal precipitation. The latest green cross corresponds to the predicted value for the 2015 year.

Figure 4 presents the precipitation forecasts and the probabilistic precipitation forecasts over Bhutan. Figure 4 at right shows probabilistic precipitation forecasts under the form of category (below normal, normal and above normal). Precipitation was predicted normal to slightly above normal.

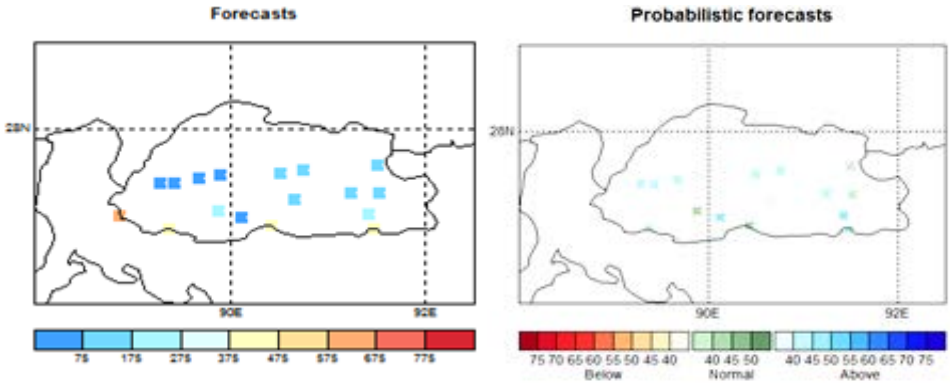

Figure 4: *Precipitation forecasts (left) and probabilistic precipitation forecasts (right)*

Sectoral requirements for climate services

Sectoral working groups (agriculture, energy/hydropower/disaster risk reduction) developed/ delivered presentations on the status of the interpretation of seasonal climate outlook information in Bhutan and on preparedness measures that would be put in place for the winter 2015 season based on the climate prediction developed by DHMS.

The challenge posed by the lack of historic climate data for Bhutan was raised by several stakeholders during NCOF-1. The experts suggested investigating the possibility of using proxy data to reconstruct past climate conditions. Natural recorders of climate conditions in Bhutan could include tree rings, ice cores, and fossil pollen; in addition, historical data such as that recorded by monks could be analyzed.

Outcomes

Presentations were delivered by DHMS on seasonal prediction in Bhutan and the services provided to the relevant national stakeholders. The group work presentations in the sectors of agriculture, health, disaster risk reduction and hydropower highlighted the demands for climate services ranging from short- to long- range prediction. To meet the demands of the users, participants agreed on the need to strengthen the technical capacities of DHMS to develop seasonal

climate predictions, interpret uncertainties, and communicate climate information relevant for decision-making to key sectoral users.

Similarly, participants recognized the importance of developing the capacity of the users to strengthen their application of the services provided by DHMS. Regular feedback from the users should be collected by DHMS in order that it further enhance its services. Participants agreed that users would be expected to define their climate services requirements and to develop the capacity to apply the climate information.

The sectoral presentations and plenary discussion revealed: ;

- the need to strengthen the technical capacities of DHMS to develop seasonal climate predictions;
- the usefulness of DHMS staff members participating in CMA training that could be offered on the FODAS tool;
- the need to hold an annual NCOF prior to the summer monsoon and immediately after SASCOF; and
- the importance of having instilled a dialogue between DHMS and sectoral stakeholders.

National Stakeholder Consultation (NSC) for Climate Services

DHMS, Bhutan is the sole agency in the country that provides climate services. The NSC provided the platform for interaction among sectoral stakeholders (representatives of governmental agencies; non-governmental organizations, inter-governmental organizations and the private sector) and DHMS in order to strengthen the application of climate services that DHMS does/could provide.

Objective

The NSC consisted of a scoping and planning exercise whose goal it was to chart the implementation of g specific climate services in Bhutan. The NSC defined the needs, priorities and roles of various stakeholders in Bhutanese climate services and offered the opportunity to DHMS to present the various climate services it provides to priority sectors in Bhutan; and to enumerate the challenges faced by the DHMS in producing and providing the services.

Analysis of climate services requirements, gaps and opportunities in Bhutan

The priority sectors of agriculture, health, energy, water, and disaster risk reduction outlined their climate services requirements; described their use of climate services provided by DHMS; and identified gaps in climate services application that should be addressed. The GFCS initiative was presented to the NSC participants, and the relevance of GFCS at the national level and means of implementing GFCS were explored. Experts from RIMES and WMO led a discussion on regional capacities for providing climate services and global operational mechanisms for providing climate services.

Sectoral breakout groups consisting of DHMS staff members and sectoral stakeholders (disaster risk reduction, energy/hydropower, agriculture/biodiversity and health) and facilitated by sectoral Experts, developed draft versions of concrete proposals for sectoral projects to deliver climate information relevant for decision-making. The proposals addressed *inter alia* the beneficiaries, outputs, activities, inputs and partners of the sectoral projects (see sections below that further discuss the sectoral proposals). .

The NSC considered the possibility of establishing and operationalizing a National Framework for Climate Services (NFCS) in Bhutanthrough the following actions:

- involving top level leadership, management and key players in climate sensitive sectors to provide strong institutional support;
- strengthening the national capacity to develop and deliver climate information and services, and identifying existing gaps in the provision of climate services to the priority areas;
- developing climate knowledge capacities in key climate sensitive government agencies and other institutions in Bhutan;
- raising public awareness of climate variability and change; and
- operationalizing a sustainable National Climate Outlook Forum process.

Outcomes

The NSC produced the following outcomes::

- strengthened understanding of both DHMS and sectoral stakeholders of climate service priorities in Bhutan; current status of provision of climate information/services, and the challenges faced in the provision of same;

- awareness of participants of regional and global capacities and mechanisms for providing climate services;
- agreement on the need to establish a Framework for Climate Services at the National Level (NFCS) and suggested way forward; and
- formulation of sectoral proposals for the strengthening of the provision and use of climate services in the following sectors agriculture/biodiversity; energy(hydropower);disaster risk reduction (including hydrology) and health (see proposals below).

Sectoral proposals on climate services: Agriculture and biodiversity; Energy; Disaster risk reduction (including Hydrology); and Health

1. Agriculture and biodiversity

SECTOR:	**AGRICULTURE**	**Biodiversity**
1. Project /Services	69% of population farmer and employing 56% of total population. Contributes 16% to GDP. Weather and climate information for making decisions in agriculture planning	Climate Sensitivity study in preserving biodiversity with special reference to Agro-biodiversity
2. Description	Provision of climate-based advisory services to farmers growing staple crops as follows: • Advisories targeted at specific crops and at different agro-ecological zones. • Forecasts on rain, temperature wind. • Agronomic practices. • Pests and disease management. • Harvests and post harvest practices	Mountain ecosystems with very diverse micro environments. To preserve this rich biodiversity, sensitivity studies on the effect of climatic parameters on the yield, growth and resistance against pest and diseases specific to a crop variety needs to be conducted. This may include ecological requirements of the existing crops and for the new crops under the changing scenarios.
3. Objective	To achieve food and nutrition security.	Identify climate sensitive areas, sensitive crops and varieties and breeds with reference to the changing climatic scenarios.
4. Benefit	• Assist farmers to decide on appropriate farming practices in coping with current climatic risks. • Increased agricultural food productivity and production. • Aid in planning and decision making processes. • Provide information for researchers and extension workers.	• NBC- capacity building for all pattern formulating action plans (NBSAP), • DOA- Policy inputs into the Renewable Natural Resources (RNR) Sector Adaptation Plans (SAPA) and all other related policy documents. • RNRRC- Identify genetic materials for developing new climate resilient varieties and breeds • Farmers- Availability of improved climate

		resilient crop varieties and breeds. • General Public- Food and Nutrition Security and sustainable utilization of natural resources and preservation of the environment.
5. Output	• Agromet Advisory Bulletins • Crop Weather Outlooks • Crop yield forecast for planning appropriate interventions • Crop Weather Models, • Crop Weather Calendars • Fortnightly Aridity Anomaly Maps • Warnings for pests and diseases	• Climate sensitive area maps, list of sensitive varieties and breeds.
6. Activities	• Constitute a technical working group to co-ordinate the activities. • identification of different agro-climatic zone • identification/establishment of unit responsible for issuing advisory (through research centers). • preparation of format of bulletin • establishment of observatory and communication network • training • involvement of all the stake holders in the field of agriculture • website development • Review meetings with stakeholders.	• Collection of long term series historical data on climate and crops. • Climatic projection for 2030 period. • Downscaling of climate projections for 2030. • Define climate, soil, topography thresholds for target varieties and breeds • Field Surveys. • Biophysical modeling. • Capacity development.
7. Inputs	• climatic normal of met parameters • real time realised data • medium range forecast • fortnightly/monthly climate outlook • NDVI • other irrigation source • crop input: stage and state • Research and development output • Financial and human resources.	• Historical data on climate. • Historical data on crops and livestock. • Financial resources. • Human Resources. • Tools for analysis and projections. • Logistics. • Soil and DEM
8. Partners	• DoA. • RDCs, extension and Local government authorities. • DHMS. • print and broadcast media • telecom service provider • RICB/BIL.	• DoA (RDCs, Extension). • NBC. • DHMS. • Department of Livestock. • College of Natural Resources (CNR). • Ugyen Wangchuck Institute of Conservation and Environment (UWICE).

2. *Energy*

SECTOR:	ENERGY		
1. Project /Services	• Historical data/climatological data up to 50 years • Optimal/Efficient design of the hydro infrastructure	• Seasonal forecast of river run-off/sediment data for the operation and maintenance of Hydropower Plants	• Climate projections for planning design of future hydropower plants/transmission & distribution
2. Description	• Quality controlled, Time series of meteorological-hydrological variables	• Seasonal forecast of rainfall & temperature • Snow melt data and Sedimentation	• Information on future climate scenarios in Bhutan for expansion of renewable (Hydropower, wind, solar & biomass energy) energy • Design of Transmission & Distribution structures in Bhutan
3. Objective	• Cost effectiveness in planning, design, construction and operation of hydro projects	• Optimize management of water resources in context of hydropower operation • Continuous reassessment to maintain optimal balance between power generation & downstream water for community needs & environmental flow	• Sector relevant information for energy planning for medium and long term timescale • Guide future investment in Bhutan for energy sector
4. Benefit	• Efficient & effective operation of hydropower plants (operating rule and levels) • Increase flexibility in balancing power generation • better risk management/assessment • Increase resilience and preparedness for hazard downstream of dam	• Efficient & effective operation of hydropower plants (operating rule and levels) • Maximize generation of power (using the forecast data) • Sustainable power supply (Augmentation wherever possible) • Reduce the cost of maintenance of hydropower plants (Machine breakdown)	• Informed decision for energy investment (economical & political leaders) • Contribute towards achieving the goal of self-sufficiency • Ensure sustainable development in Bhutan
5. Output	• Precipitation time series including annual rainfall duration curve • Soil moisture • River flow including	• Seasonal forecast of river run-off & sediment • Early warning systems • Parameters for developing models	• Future scenarios of all variables • Sub-sector climate relevant information on future scenarios,

	duration curve • wind, temperature and humidity • Soil type, Land use, Glacier volume data • Sediment (composition of bed load) including sediment rating curve	(landuse, soil type, humidity..) • Snow melt contributions	
6. Activities	• Downscale of reanalysis combined with in-situ observation for optimal interpolation • Evaluate the usefulness of satellite data	• Improve seasonal forecast • National Climate Outlook Forum (NCOF) products • Pilot on applicability of the received data • Model assessment & development	• Analysis of global/downscaled models, • Assessment/inventory of existing global/ regionals climatic scenarios • Generate output for relevant sub-sectors • Estimate uncertainties and • communication of the output (collaborate with sub-sectors)
7. Inputs	• Capacity development of DHMS • Enhance analytical skills • Expertise	• River run-off model • Hydrological models • Sedimentation model • Reservoir simulation model • Historical data for models verification • Meteo forecasts	• Research on combination of different models/ information to have robust data • Capacity building of DHMS officials
8. Partners	• WMO International and Regional Climate Centers • Regional hydro-met Centers • ICIMOD, Nepal • RIMES, Thailand • Global Earth Observation (GEO) • FMI, IMD, CIRES	• DHMS, BPC, DHPS, GPC, NEC, BEA	• Decision makers, researchers, Regulators (BEA, NEC, DoA, DoFPS, etc.) • World climate research program • IMO,IMD, IPCC

3. Disaster risk reduction

SECTOR:	**DISASTER RISK REDUCTION**	
1. Project /Services	Disaster Information System for Bhutan	Rainfall Run-Off Modeling for Small Catchments

2. Description	**Phase 1:** A database that integrates information about past hydro-meteorological events, their causes, effects and impacts **Phase 2:** A system that evaluates impacts of future events, based on historical database	• Generation of hydrological behavior of small catchments using 10 days forecast
3. Objective	• Understanding individual hazard/disaster • Provide inputs for facilitating disaster statistics • Deriving lessons for guiding mitigation and preparedness, preventing future losses	• Provide guidance on the likely water condition in the coming 10 days • Overall reaction of small catchments of (intensive) rainfall • Provide early warning for preparedness
4. Benefit	• **Department of Disaster Management:** lessons for disaster management, build back better concept • **Research Institutions**: models • **Insurance Companies**: basis for underwriting • **Environment Commission**: input for state of environment reporting, input for baseline • **Department of Engineering Services**: design criteria • **Development Planners**: hazard and risk assessment for feeding into design criteria	• **Department of Disaster Management**: disaster preparedness • **Public Authorities**: reduction of damages and economic losses • **Department of Engineering Services, Flood Engineering Management Division**: design criteria (based on long-term discharge data)
5. Output	• Events distribution map • Disaster statistics	• Rainfall discharge model • 10 days water discharge outlook
6. Activities	• Database design, to include GIS : • Database system development • Data collection : • Data collection guideline (to include data collection methodologies, i.e. from most recent to past) • Capacity building in data collection • Quality Control • Validation of data • Data analysis • Data dissemination	• Model development • Model calibration • Model testing • Translation of model outputs into management strategies
7. Inputs	• Dedicated personnel in DHMS, DDM, DES, NEC, DGM • Hardware (computer, server) • GIS software (open-source) • Capacity building of relevant personnel	• Dedicated personnel in DES, DHMS (in collaboration with research institutions/universities) • Hardware (computer, server) • Modeling software • Capacity building of relevant personnel

8. Partners	• DHMS • DDM • DES • NEC • DGM • Insurance companies • Media	• DES • DHMS • Research institutions/universities • DDM • NEC • DGM

4. Health

SECTOR:	**HEALTH**	
1. Project /Services	• Integrated surveillance or risk monitoring for climate sensitive diseases	• Seasonal outlook for malaria control programmes
2. Description	• Pilot EW info for diarrhoea based on results from initial 4 districts (maybe for internal use) • Data collection and research on climate sensitivity for possible expansion to additional 9 districts	• Pre-monsoon outlook for vector control programme
3. Objective	• Reduced incidence of diarrhoeal cases through early warning information to the public and health authorities tested and piloted • Strengthened surveillance system • Establishment of climate-disease relationships • Research results incorporated in EWS	• Reduce/prevent malaria outbreaks • Resource efficiency and effectiveness of programmes (drainage, spraying, nets, cisterns, treatment preparation) based on expected seasonal rainfall
4. Benefit	The ultimate beneficiaries are affected **communities** who will experience improved climate-related health outcomes; in the short term the beneficiaries will be **health professionals** who will gain the knowledge necessary for the establishment of the system.	Increased **happiness**: The ultimate beneficiaries are the **communities**, who experience reduced malaria incidence; public health authorities and control programme and post-season surveillance programme benefit through resource optimization
5. Output	• Diarrhoeal health advisories, backed by communication channels, identified appropriate actions and response plans • Strengthened surveillance system (including on-going data collection, databases and analysis) • Evidence base (data and analysis) on climate-disease relationships sufficient to support EWS	• pre-season outlook including onset, cessation and total precipitation of the monsoon, at the most localized spatial resolution possible • Advisories to Community Health Action Groups • response and surveillance actions and plans incorporating outlook information

6. Activities	• Train health professionals on surveillance system • Establish data requirements and data collection protocols • Data rescue and database construction • Analyses and consultative meetings to review results • Identification of response actions and formulation of response plans • Development of health advisory prototype(s) (e.g. for communities and health professionals) • Testing of health advisory prototype and response plans	• Development of forecast tool to support outlook • Development of outlook product • Identification of options (adjustments to timing, intensity of effort, allocation of resources) for control and surveillance programmes and actions under differing seasonal scenarios • Training to control programme, surveillance programme and CHAG personnel • Testing and feedback • Incorporation into operations
7. Inputs	• Staff allocation and mobilization (e.g. from partner institutions) • Consultants • Workshops • Travel • Other (e.g. publications) • For each activity (TBD), from which a budget and timeline can be developed	• Staff allocation and mobilization (e.g. from partner institutions) • Consultants • Workshops • Travel • Other (e.g. publications) • For each activity (TBD), from which a budget and timeline can be developed
8. Partners	• DoPH, DHMS, GFCSO, WHO, university on medical sciences	• DoPH, DHMS, CHAGs, district administration, control and surveillance programmes, GFCSO, WHO, university on health sciences

Conclusions, recommendations, and the way forward

Conclusions

NCOF-1 and NSC in Bhutan have greatly assisted DHMS and sectoral stakeholders in understanding the importance of climate services. The two events brought together the provider, DHMS, and sectoral users of climate services. NCOF-1 and NSC identified the capacity of DHMS to provide and communicate climate services, as well as the gaps that must now be addressed: gaps associated both with the provision of climate services, and the effective application by Bhutan's priority sectors of these services.

The sectoral project proposals formulated during the course of the NSC provide an excellent basis for DHMS to develop a climate services strategy that could be implemented, both with Bhutanese and other partners. Building on its new institutional structure that will facilitate the provision by DHMS of climate

services, DHMS will seek to further develop its collaboration and cooperation with regional and bilateral climate services partners.

Recommendations

NCOF -1 and NSC generated a series of recommendations to enhance the provision of climate information and services in Bhutan. . NCOF-1 recommended that the NCOF mechanism be institutionalized in a sustainable fashion, and that an annual NCOF be held prior to the summer monsoon and immediately after SASCOF; The NSC addressed the implementation of the National Framework for Climate Services (NFCS) in Bhutan and resulted in the development by NSC participants of sector- specific project proposals outlining service requirements for the agriculture, energy, disaster risk reduction and health sectors (ref: proposals provided on pp 12-18); capacity gaps and requirements associated with the provision and use of climate services were also presented, and means of addressing these gaps explored. The following specific recommendations were formulated at the NSC and NCOF:

NCOF:

- to hold an annual NCOF prior to the summer monsoon and immediately after SASCOF;
- to develop the capacity of providers and sectoral users of climate services to effectively develop and apply climate services; and
- given the lack of historic climate data for Bhutan, explore various possibilities to reconstruct historic data.

NSC:

- to establish a National Framework for Climate Services (NFCS) including:

(a) investigating appropriate institutional mechanisms for guiding climate services:

1) Steering Committee at the policy level;

2) Technical Committee;

3) Sector-specific working groups (agriculture; energy, DRR (including hydrology) and health)

(b) formulating a comprehensive strategy for climate services implementation;

(c) identifying vehicles to support project implementation (e.g. GEF, PPCR, GCF, bi-lateral); and

(d) harnessing PAC resources to support (a), (b) and (c) at regional and global levels; and capturing lessons learnt for upscaling.

The way forward: NCOF and NSC follow-up

Shortly DHMS will be restructured and become an autonomous body. Along with its new structure, the DHMS aims to enlarge the scope of its focus from climate monitoring to provision of climate services. The new DHMS structure will support the implementation in Bhutan of the GFCS initiative at national level via the development of a NFCS.

Subsequent to the NSC, the following climate services-related initiatives were undertaken/developed by DHMS and its partners/stakeholders:

- Capacity development of DHMS staff members: training provided in October 2015 on climate services (data analysis) at FMI, Helsinki, under the FMI project *Strengthening of the Hydro Met Services in Bhutan*;
- Agro-met training to be held at IMD in April 2016 and funded by the FMI project *Strengthening of the Hydro Met Services in Bhutan*;
- Training course on GFCS and FODAS to be conducted by WMO and BCC and hosted by CMA in Beijing in April 2016; a DHMS official will participate;
- SASCOF-8 will be held in Sri Lanka in April 2016 and be attended by DHMS; financial support will be provided by *Programme for Implementing the GFCS at Regional and National Scales*, funded by Environment Canada;
- NCOF-2, Bhutan, will be held on 12 May 2016 with technical support provided by RIMES, Thailand, and financial support provided by *Programme for Implementing the GFCS at Regional and National Scales*, funded by Environment Canada;

- Integrated surveillance or risk monitoring for climate sensitive diseases: the Department of Public Health (DoPH) will extend surveillance to eastern Bhutan (climate station has been selected and the programme is in progress);
- Drafting of Bhutan Hydro-meteorology Services Policy is in progress;
- Formulation of the World Bank Project *Strengthening Weather and Hydrological Forecasting and Services* that foresees:
    - Development of a Common Operating Platform for automated hydro-met services delivery;
    - Design of an agro-met decision support system, and generation of agro-met information products and dissemination to two Dzongkhags; and
    - Installation of the ceilometer and wind profiler at the international airport.
- Restructuring of DHMS to facilitate its delivery of climate services;
- Proposed inclusion within the purview of the Multi Sectoral Task Force Committee on Climate Change (MSTFCCC) led by the National Environment Commission, Bhutan ,of the recommendations and ToRs of NFCS;
- MSTFCCC meeting is scheduled to be held in mid of April/May 2016;
- Analysis of the *Survey on Climate Services User Needs for Bhutan* that was conducted by the FMI Climate Expert during the NSC; the survey revealed:
    - high demand by by user sectors for historic climate data as well as future climate projections;
    - high demand for gridded datasets of temperature and precipitation;
    - high demand for iinformation on future climate scenarios of Bhutan;
    - high demand for strengthened climate services; and
    - other major requirements including reanalysed datasets, impact studies, hydro- meteorological indices, hazard maps and catalogue of events, early warning and extreme weather warning services.

Annex 1: List of participants

Name	Organization	Acronym	Email
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Annex 2: Agenda for NCOF

~~Time~~	~~Activity and speaker~~	~~Chair of session~~
9:00- 9:30 am	Registration	
9:30 – 10:25 am	**Session 1: NCOF and NSC opening ceremony**	**Tayba Tamang, DHMS**
9:30 –9:45 am	Welcome address **(Offg. Director, DHMS)**	
9:45 – 10:00 am	Presentation on the role of NCOFs within the GFCS mechanism **(Maxx Dilley, Director CLPA)**	
10:00 – 10:25 am	Keynote address by Chief Guest **(Secretary, MoEA)**	
10:25 – 10:50 am	**Coffee/tea break and Group photo**	
10:50 – 12:00 pm	**Session 2: National Climate Outlook Forum in perspective**	**Offg. Director, DHMS**
10:50-11:25 am	National Climate Outlook Forum (NCOF) - Objectives and expected outcomes - Climate information and services in Bhutan: current status and future plans - Review of recent seasonal outlook performance in Bhutan by climactic zone **(Tayba Tamang, Meteorology Division, DHMS)**	
11:25-11:45am	Climate outlook techniques and analysis: • Climate data issues including availability and quality • Communication and interpretation of uncertainties in seasonal climate outlooks • Presentation of CMA Forecast System on Dynamic and Analogy Skills (FODAS) **(Ruby Rose Policarpio, RIMES and Zhiqiang Gong, GFCS Office/BCC)**	
11:45-12:00 pm	Discussion	
12:00 – 1:00 pm	**Session 3 (part 1) : National seasonal outlook**	**Maxx Dilley, WMO**
12:00-12:45 pm	Seasonal outlook/forecasting in Bhutan: • Presentation of Winter SASCOF consensus outlook **(Ugyen Chhophel, DHMS and Ruby Rose Policarpio, RIMES)** • National precipitation and temperature seasonal outlook for late autumn/ winter 2015/2016 (November to February). **(Ugyen Chhophel, DHMS)** • Use of relevant inputs from Global Producing Centres (GPCs), Regional Climate Centres (RCCs), and Regional Climate Outlook Forums (RCOFs) **(Ruby Rose Policarpio, RIMES and Zhiqiang Gong, GFCS Office/BCC)** • Challenges in preparing seasonal forecasts in Bhutan **(Ugyen Chhophel, DHMS)**	
12:45-1:00 pm	Discussion	

1:00-2:00 pm	**Lunch**	
2:00-3:45 pm	**Session 3 (part 2) : National seasonal outlook**	**Maxx Dilley, WMO**
2:00-3:00 pm	Work in Break-out Groups (BG) on the usefulness and interpretation of the seasonal climate outlook information and preparedness measures for the upcoming season: • BG I Agriculture • BG II Energy/Hydropower • BG III Disaster Risk Reduction	
3:00-3:15 pm	Break-out Group Presentations (5 minutes each group)	
3:30 –3:45 pm	Discussion	
3:45-4:05 pm	**Coffee/tea break**	
4:05 -5:00 pm	**Session 4: Sustaining the NCOF process and enhancing decision-support**	**Offg. Director, DHMS**
4:05 – 4:15 pm	Discussion on climate information and service delivery, accessibility, format and applicability between NCOFs **(Ruby Rose Policarpio, RIMES and Sonam Rabten, Meteorology Division, DHMS)**	
4:15 – 4:35 pm	Capacity development needs • Speaker from DHMS on future capacity building needs **(Tayba Tamang, DHMS)** • Speakers from stakeholder agencies on potential climate service needs **(Department of Agriculture/Department of Hydropower and Power Systems)**	
4:35-4:45 pm	Discussion led by Tayba Buddha Tamang, DHMS and Maxx Dilley, WMO	
4:45-5:00 pm	Wrap up: • Next steps in providing consensus-based seasonal outlooks tailored for the agriculture, energy/hydropower, and disaster risk reduction sectors • Scoping of Bhutan NCOF process: frequency and timing of regular NCOFs **(Maxx Dilley, WMO)**	

Annex 3: Agenda for NSC

Time	Activity and speaker	Chair of session
9:00- 9:10 am	Registration	
9:10– 9:45 am	**Session 1: Welcome**	**Tayba Tamang, DHMS**
9:10– 9:20 am	Welcome statement **(Offg. Director, DHMS)**	
9:20– 9:45 am	Presentation on GFCS implementation and the National Context **(Tamara Avellan, GFCS Office)**	
9:45-10:45 am	**Session 2: Introduction to the NSC programme**	**Maxx Dilley, WMO**
9:45-10:15 am	NSC objectives and NSC work programme	
10:15-10:35 am	World Bank: Brief report on "Modernizing Weather, Water and Climate Services: A Road Map for Bhutan" (Ms Dechen Tshering, World Bank)	
10:35-10:45 am	Introduction of experts and participants including brief discussion of participants' expectations	
10:45-11:05 am	**Coffee/tea break**	
11:05-12:30 pm	**Session 3 (Part 1): Status of provision and application of climate services in Bhutan: exploring climate services requirements of priority sectors**	**Maxx Dilley, WMO**
11:05-11:30 am	Provision of climate information and services in Bhutan: user expectations ; current status and challenges faced (**Chimi Wangda, Meteorology Division , DHMS and Reija Ruuhela, FMI)**	
11:30-12:30 pm (presentations by 3 sectors)	Perspective from users of climate information in Bhutan: 20 minute presentation by each GFCS priority sector on: • sectoral climate sensitivity and impacts • requirements for climate information and services • climate information and services presently available, and identification of gaps Presentations by the disaster risk reduction **(DDM, World Bank)**, energy/hydropower (**DHPS, DRE, DGPC, BPC/BEA)** and agriculture sectors (**DoA, NBC)**	
12:30-1:30 pm	**Lunch**	
1:30-3:10 pm	**Session 3 (Part 2): presentations and discussion, continued**	**Maxx Dilley, WMO**
1:30-2:10 (presentations by 2 sectors)	Climate information users' presentations, continued: Presentations by the health **(DoPH)** and water sectors **(Watershed Management Division, DGM)**	
2:10-3:00 pm	Panel discussion/brief presentations by experts in the sectors of agriculture, energy/hydropower, disaster risk reduction **(Sanjib Bandyopadhay, Markus Zimmermann; Roberta Boscolo; Reija Ruuhela)**	
3:00-3:10 pm	Discussion	
3:10-3:30 pm	**Coffee/tea break**	
3:30-5:00 pm	**Session 4: Provision of climate services globally and in the South Asia region**	**Ruby Rose Policarpio, RIMES**
3:30-3:50 pm	Results of global survey on climate services requirements **(Reija Ruuhela, FMI)**	

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3:50-4:05 pm	Regional status of capacities for providing climate services and climate information **(Ruby Rose Policarpio, RIMES)**	
4:05-4:20 pm	Operational mechanisms for providing climate services globally (**Maxx Dilley, WMO)**	
4:20-4:45 pm	Discussion	
4:45-5:00 pm	Wrap up of the day's discussions **(Reija Ruuhela, FMI)**	

Wednesday, 21 October.

Time	Activity and speaker	Chair of session
9:00– 11:15 am	**Session 5: User perspective and institutional framework for climate services in Bhutan**	**Maxx Dilley, WMO**
9:00-9:30 am	Meeting user needs for climate services and information: • how to develop the user/supplier relationship • how a Meteorological Service can respond to user needs **(Tamara Avellan, GFCS Office)**	
9:30-9:45 am	Discussion	
9:45-10:30 am	Establishment of the Framework for Climate Services at the National Level (NFCS)- creating an institutional framework that supports the provision of timely and relevant climate services and information: • overview of existing institutional framework for climate services in Bhutan **(Phuntsho Namgyel, Chief, PCRD, DHMS)** • identification of necessary coordination and collaboration mechanisms **(Phuntsho Namgyel, Chief, PCRD, DHMS and Tamara Avellan, GFCS Office)**	
10:30-11:00 am	Panel discussion by stakeholders and experts	
11:00-11:20 am	**Coffee/tea break**	
11:20-12:30 pm	**Session 6 (Part 1): Development of concrete proposals to strengthen the provision and use of climate services by the priority sectors of Bhutan:**	**Offg. Director, DHMS**
11:20-1:00 pm	Formulation of proposals by sectoral working groups (WGs) • Formation of a sectoral (WG) for each priority sector (agriculture, energy/hydropower, and disaster risk reduction); each WG shall consist of sectoral stakeholders, DHMS representatives and a sectoral expert • Formulation of a proposal by each sectoral WG that identifies: priority sub-sectors within each sector;	

11:20-1:00 pm,	required institutional mechanisms; required climate	

cont	tools, information and services; means of facilitating communication between providers and sectoral users of climate information; and capacity development needs.	
1:00-2:00 pm	**Lunch break**	
2.00-4:15 pm	**Session 6 (Part 2): Development of concrete sectoral proposals, continued**	**Offg. Director, DHMS**
2:00-3:00pm	Continuation of formulation of sectoral proposals	
3:00-3:45 pm	Sectoral WM presentations: 3 presentations of 15 mins each	
3:45-4:05 pm	**Coffee/tea break**	
4:05-4:20 pm	Summary of sectoral climate information users' proposals, and identification of realistic next steps **(Bhutanese sectoral stakeholder, TBD; Reija Ruuhula, FMI)**	
4:20-4:45 pm	**Session 7: The way forward to strengthen the provision of climate services and information in Bhutan**	**Maxx Dilley, WMO**
4:45-5:00 pm	Closing of meeting	**Offg. Director, DHMS**