ANNUAL REPORT
2019-2020

NATIONAL CENTER FOR HYDROLOGY AND METEOROLOGY
ROYAL GOVERNMENT OF BHUTAN
THIMPHU: BHUTAN
2020

Acronyms:

11 FYP	Eleventh Five Year Plan
12 FYP	Twelfth Five Year Plan
AWLS	Automatic Water Level Station
AWS	Automatic Weather Station
DDM	Department of Disaster Management
DGM	Department of Geology and Mines
DGPC	Druk Green Power Corporation
DHMS	Department of Hydro-met Services
DIT	Department of Information Technology
DoLG	Department of Local Governance
EWS	Early Warning System
FWS	Flood Warning Section
GEF	Global Environment Facility
GLOF	Glacier Lake Outburst Flood
GoI	Government of India
HQ	Headquarter
ICT	Information Communication Technology
JICA	Japan International Cooperation Agency
IFAS	Integrated Flood Analysis System
LDCF	Least Developed Country Funding
MD	Meteorology Division
MHPA	Mangdechhu Hydropower Project Authority
MoHCA	Ministry of Home and Cultural Affairs
NEC	National Environment Commission
NWFWC	National Weather Flood and Warning Centre
OEM	Original Equipment Manufacturer
PCRD	Planning, Coordination and Research Division
PHPA-I	Punatsangchhu Hydropower Project Authority- I

PHPA-II	Punatsangchhu Hydropower Project Authority- II
RIMES	Regional Integrated Multi-Hazard Early Warning System
R&D	Research and Development
RCSC	Royal Civil Service Commission
RGoB	Royal Government of Bhutan
SOP	Standard Operating Procedure
UNDP	United Nation Development Programmed
WMO	World Meteorological Organization
NCHM	National Center for Hydrology and Meteorology
HSDRRP	Hydro Met Services and Disaster Resilience Regional Project
WB	World Bank
WRF	Weather Research and Forecast.

Table of Contents

Acronyms: i

1. Organization 1
2. Governing Board 1
3. Vision, Mission and Core Values 2
4. Mandates 3
5. Organization Structure and Staffing 5
6. Center's 12 FYP (2018-2023) 7
7. Annual Performance Target (APT) for 2018-2019 FY 8
8. Summary of Financial Statement 13
9. Highlights of Climate Status in Bhutan for the year 2019 13
10. Highlights of Hydrology and River flow in Bhutan for the Year 2019 15
11. End-to-End Operational of National Framework for Climate Services (NFCS) 17
12. Agro-meteorological services 20
13. Aviation Meteorological Services 21
14. Hydrology and Water Resources Services 23
15. National Hydro-met Observation Network 30
16. Cryosphere Monitoring and Services 35
17. Publications and Reports 44
18. Extreme Events Warning and Advisories 46
19. Project 46
20. Institutional Linkages and Collaboration 47
21. Institutional Strengthening of Hydro-met Sector 49
22. Governing Board Meeting 51
23. Bilateral Meeting 52
24. Regional and international meeting 54
25. Important events 57
26. Human Resources Development 67
27. Wellbeing of staff 71
28. Challenges and Issues 73

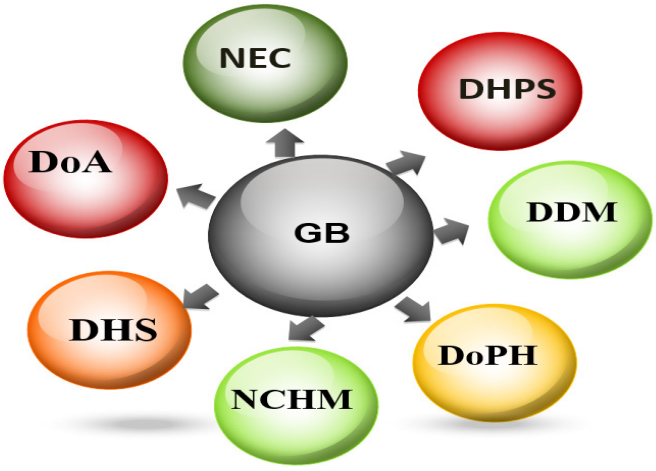
1. Organization

The National Center for Hydrology and Meteorology (NCHM) is a scientific and technical autonomous agency of the Royal Government of Bhutan created in 2016. The Center was created to improve the efficiency and effectiveness in providing information and services of hydrology, meteorology, cryosphere and climate sciences to support the line agencies and the public.

2. Governing Board

The Center is governed by a Governing Board (GB) with its members approved by the Cabinet from relevant sectors. The GB is Chaired by the Secretary, National Environment Commission Secretariat. Detail of GB members are given below.

a. Secretary, National Environment Commission Secretariat (NEC)- Chairman
b. Director General, Department of Disaster Management (DDM), Ministry of Home and Cultural Affairs (MoHCA)- Member
c. Director, Department of Agriculture, Ministry of Agriculture and Forestry (MoAF)- Member
d. Director, Department of Public Health (DoPH), Ministry of Health (MoH)- Member
e. Director, Department of Human Settlement (DHS), Ministry of Works and Human Settlement (MoWHS)- Member
f. Director, Department of Hydropower and Power Systems (DHPS), Ministry of Economic Affairs (MoEA)- Member
g. Director, National Center for Hydrology and Meteorology (NCHM) - Member Secretary



3. Vision, Mission and Core Values

3.1. Vision, Mission and Mandates

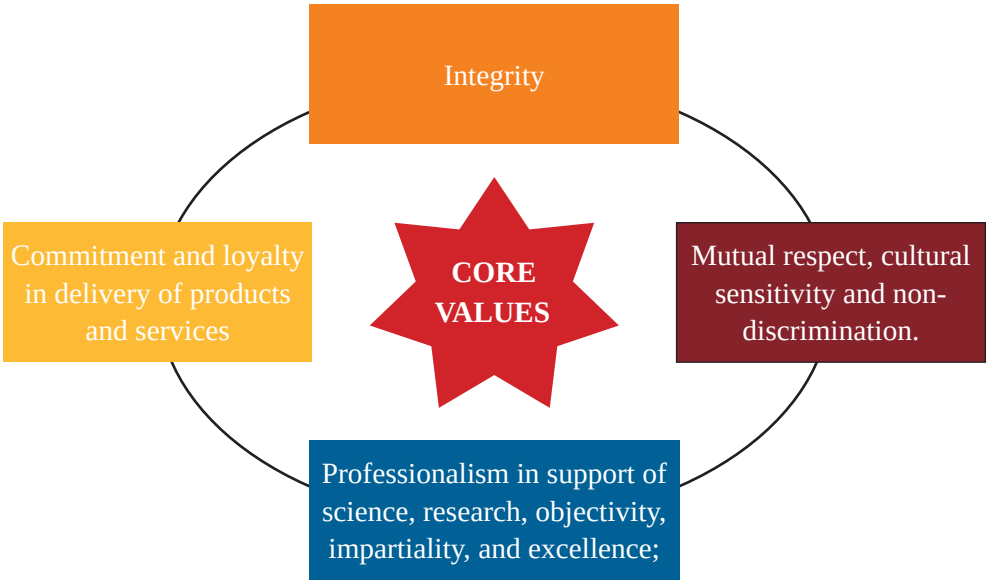
Vision

Center of Excellence in Hydrology, Meteorology and Cryosphere Science and Services

Mission

Monitoring and understanding of hydrology, weather, climate and cryosphere, for timely provision of information and services to protect lives and property and support national needs for ecologically balanced sustainable development.

3.2. Core Values



3.3. Goals

NCHM goals:

a. Improve result-based decision support service for weather incidents and events that threaten lives and livelihoods;
b. Enhance climate services to understand and adapt to climate-related risks;
c. Develop capacity to provide integrated and coupled monitoring, detection and forecast services to support assessment and management of water resources and hydro-meteorological hazards;

d. Build competence to provide sector-relevant information for socio-economic development, and support the development of integrated environmental services to foster healthy communities and ecosystems;
e. Sustain highly skilled professional workforce equipped with training, tools and infrastructure to fulfill the mission.

4. Mandates

Mandates

Provide scientific and technological services in hydrology, water resources, meteorology, climatology, and cryosphere to ensure the safety and socio-economic well-being of society and to support national and international needs.

The detail mandates are as listed below:

a. Planning and operation of national hydrological (surface and subsurface) and meteorological (surface and upper air) observation network and its communications systems required for monitoring and data collection;
b. Study and monitor cryosphere (snow, glaciers, glacier lakes, permafrost) and its associated risks to implement appropriate mitigation and adaptation measures;
c. Study and provide public weather services, severe weather warnings, meteorological data management, aviation meteorological services, agro-meteorology and climate change information and services;
d. Research and carryout water resources assessment, hydrological forecasting, hydrological data management, dissemination of hydrological data and information and provide early warning services related to flood and GLOF;
e. Assessment and mapping of hydro-meteorological and GLOF hazards at the sub-basin and basin level;
f. Capacity and human resources development through training and education;
g. Research and application of science and technology in operational meteorology, hydrology and cryosphere for development of services and products;
h. Promote collaboration and institutional linkages with national, regional and international organizations related to weather, climate, hydrology, cryosphere, and water resources for exchange of data, research and technology transfer.

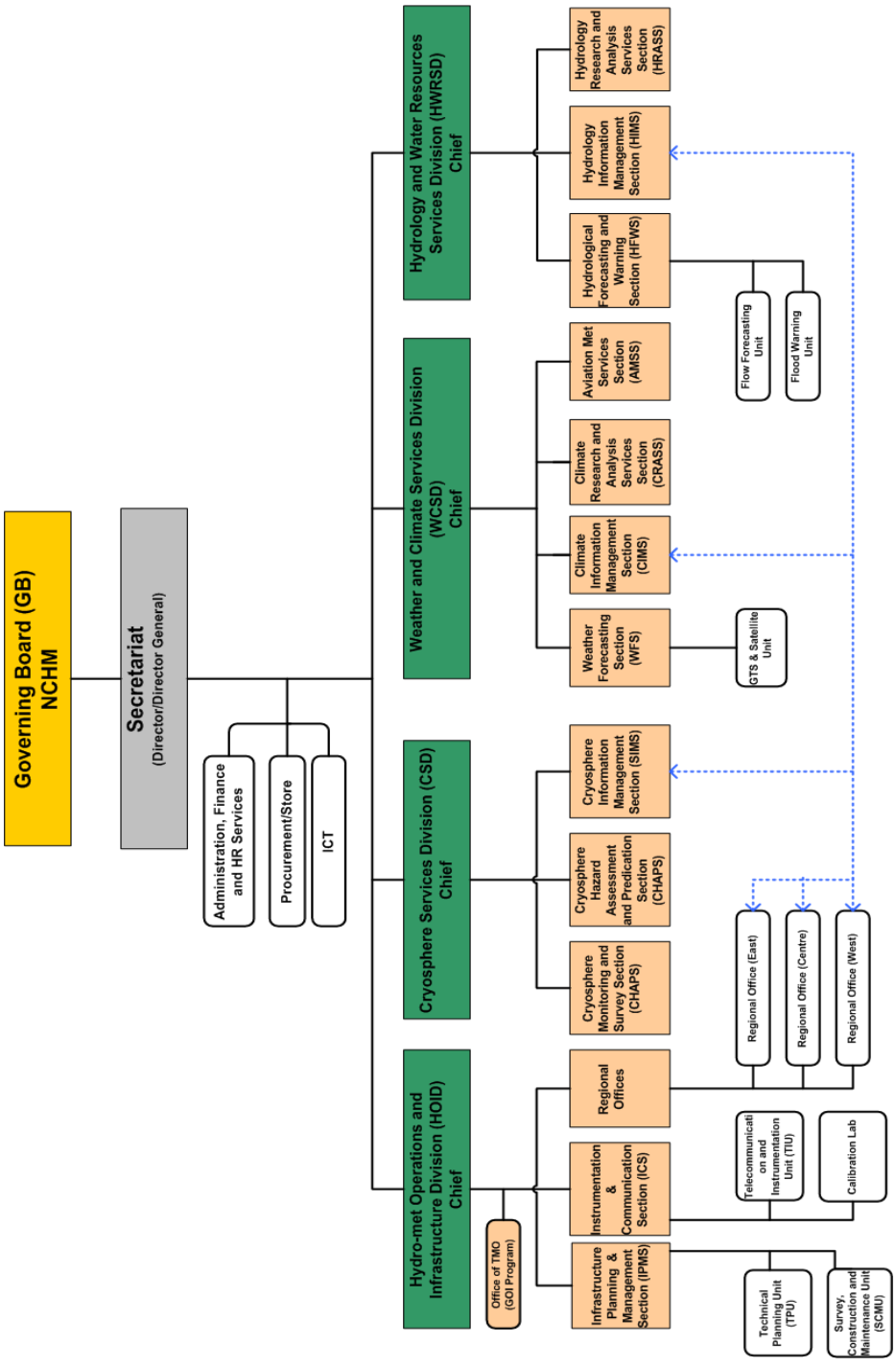


Figure 1: Approved Organization Structure of NCHM

5. Organization Structure and Staffing

5.1. Organization

The organogram of the Center is given in Figure 3.

5.2. Staffing

Currently there are 207 employees out of 220 total staff approved by the RCSC (June 2018).
5 staff are on Extra Ordinary Leave (EOL).

Table 1:Staff Strength and distribution

Division/Secretariat	Approved by RCSC	Existing	Gap	Remarks
Secretariat	21	20	-2	Including 8 Drivers and 2 ESP/GSP
Cryosphere Services Division (CSD)	8	8	0	
Weather and Climate Services Division (WCSD)	32	31	-1	
Hydrology and Water Resources Services Division (HWRSD)	16	15	1	
Hydro-met Operation and Infrastructure Division (HOID)	143	118	26	Excluding 13 RGR (GSP) under FWS, GoI Program, TMO and 2 ESP under HOID.
Total	**220**	**192**	**28**	*207 existing staff including 15 ESP/GSP under FWS/ HOID*

The detailed distribution of employees of NCHM under different position categories is given in Table 2. Since the Center is responsible for monitoring and operation of national hydro-meteorological network stations covering the whole Bhutan (about 250 national hydro-meteorological stations), the maximum staff (more than 65%) are under the Support and Supervisory category followed by Professional and Management level (18%).

Table 2: Distribution of staff based on Position Category

Position Category	No. of Staff	Remarks
Executive and Specialist	2	
Professional and Management	36	
Support and Supervisory	142	
Operational category	10	1 driver on contract
ESP/GSP	17	Including ESP/GSP under FWS
Total	**207**	

5.2.1. Staff Superannuation

Three staff superannuated during the FY 2019-2020 after serving more than three decades of dedicated services to the nation.

a. Mr. Sonam Dorji, GSP, Flood Warning Section (FWS), HOID superannuated on 2 August 2019 after serving the nation for nearly four decades (33 years). He joined the service on 6 January 1986.
b. Mr. Dorji Wangdi, GSP, Flood Warning Section (FWS) joined the service on 8 June 1984 and superannuated on 31 December 2019 after serving 35 years.
c. Mr. Phub Dorji, GSP, FWS joined the service on 1 August 1988 and after serving for three decades (31 years), he superannuated on 31 March 2020.

5.2.2. New Recruitment

As per the approval of the RCSC, a total of seven staff (2 in PMC and 5 in SSC category) joined the center with effect from 1 January 2020 under single window recruitment to fill up the gaps in manpower of the Center

Mr. Sangay Tempa and Mr. Saroj Acharya joined the Center as Meteorology/ Hydrology Officers in HOID and WCSD respectively. Mr. Pemba Dorji, Mr. Tsheten Namgay, Mr. Aita Singh Tamang, Ms. Sangay Wangmo and Ms. Sonam Lhamo joined as Meteorology/Hydrology Technician V.

6. Center's 12 FYP (2018-2023)

The Center's 12th Five Year Plan (2018-2023) has two programs that are directly linked to NRKA 6 and NKRA 17, and indirectly to all the NKRAs and SDG as weather, climate and water resources contribute or impact all the Sectors.

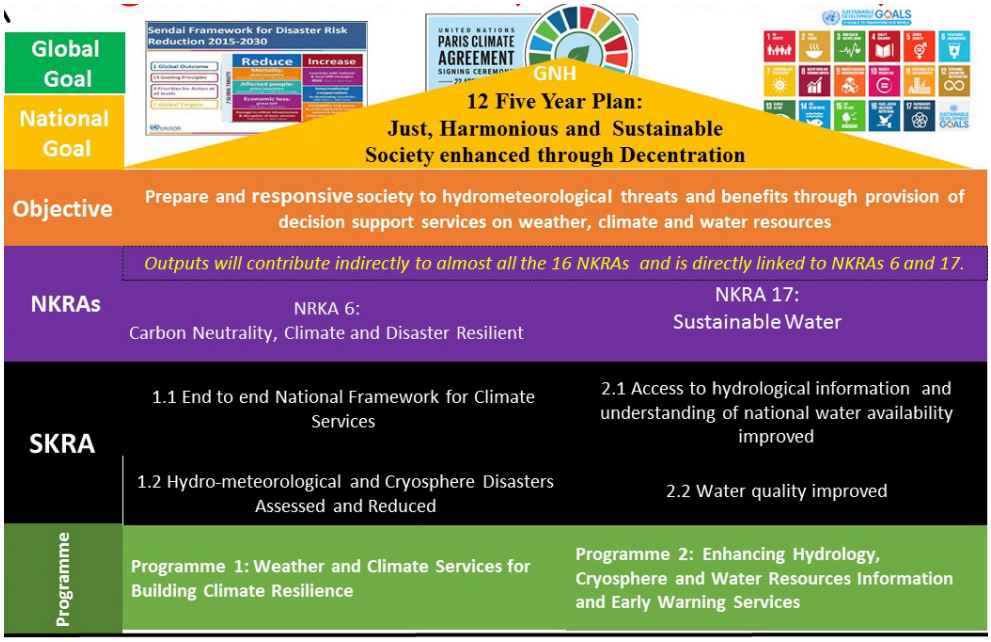


Figure 2: NCHM 12 FYP SKRAS linkage with NKRAs and other global goals

7. Annual Performance Target (APT) for 2018-2019 FY

The Center Annual Performance Target (APT) was approved and signed during the 4th Governing Board (GB) meeting held on 3 January 2020. The planned activities under the APT for 2019-2020 for NCHM are tabled below (Table No. 4) with achievements. During the FY the Center planned and implemented 41 activities to achieve five objectives outlined in the APT 2019-2020.

The five objectives are:

a. Hydro-meteorological and cryosphere disasters assessed & reduced,
b. Access to hydro logical information and understanding of national water availability improved,
c. End-to-end operational National Framework for Climate Services (NFCS) and
d. Provide effective and efficient admin, direction and related common support services.
e. Water quality improved

7.1. Signing of Annual Plan Target (APT) of NCHM for FY 2019-2020

The Annual Plan Target (APT) for the Financial Year 2019-2020 was signed between the Governing Board, Chairman/Secretary NECS) and Director during the 4th GB meeting held on 3 January 2020.

Figure 3: Signing of NCHM APT with Chairman of GB during the 4th Governing Board Meeting.

7.2. Signing of Annual Plan Target (APT) of NCHM for FY 2019-2020

The Center has been consistently rated in the "Outstanding" category with the introduction of PMS. The APT score for the FY 2019-2020 is 99.75%.

Table 3: APT Score of the Center for last four years

Sl No.	Financial Year	APT Score
1	2016-2017	97.80%
2	2017-2018	99.45%
3	2018-2019	100%
4	2019-2020	99.75%

Table 4: NCHM APT for 2019-2020 and Achievements.

APT of NCHM for FY 2019-2020 with Achievements as of June 2020					
Objective	**Action**	**Success Indicator**	**Unit**	**Planned Activities (June 2019)**	**Achievements (June 2020)**
End-to-end operational National Framework for Climate Services (NFCS)	Climate services provided	Climate services provided	Number	10	1. National Climate Forum (NCF) conducted. 2. Seasonal prediction (summer outlook) issued. 3. Seasonal prediction (winter outlook) issued 4. Climate monitoring (annual) report published 5. Historical climate data/information analysed and archive in database; Data disseminated based on users' request. 6. Update weather and climate information on the NCHM website 7. Climate projection for Bhutan issued 8. Climate monitoring (monthly) issued 9. Weather and seasonal information for agro-met services 10. Quality control of agro-met data conducted.
	Weather forecast and advisories on extreme weather events issued	Weather forecast and advisories on extreme weather events issued)	Number	6	1. Daily weather forecast (365 days) issued. 2. Weather reports prepared and issued 3. NWFWC operated on 24/7 shift for 365 days 4. Operation and maintenance of systems (GTS, HimawariCast and WRF) carried out 5. Extreme weather advisories issued and media briefing conducted 6. Common Operating Platform (SmartMet) operational
	Aviation met services provided	Aviation met services provided	Number	3	1. Operation and maintenance of aviation met equipment at all airports conducted and services provided. 2. Meteorological observations and reports (METAR/SPECI) prepared and issued daily. 3. Meteorological observation stations at all the airports upgraded.

Water quality improved	Measurement of suspended sediment loads in major rivers	Measurement of suspended sediment loads in major rivers carried out	Date	1	Sediment Sampling Station and Sediment Laboratory constructed work at Kerabari could not complete on time due to CONVID-19 situation. The work was spill over to 2020-2021.
To provide effective and efficient admin, direction and related common support services	To provide effective and efficient directorate & services	Provided effective and efficient directorate & common services	Days	3	1. Timely HRS (Human Resources Services) and AFS (Administration and Finance Services) provided. 2. ICT systems operated and provided uninterrupted services for the Center provided more than 90% availability. 3. Budget and finance services delivered within the proposed
Hydro-meteorological and cryosphere disasters assessed & reduced	Assessment and monitoring of cryosphere and associated hazards conducted	Assessment and monitoring of cryosphere and associated hazards conducted	Number	3	Annual time series measurement and monitoring of glaciers, glacier lakes and associated hazards completed. 1. Annual monitoring of benchmark glaciers (Thana and Gangju La) – 2 activities 2. Annual monitoring of Wachey glacier and glacial lakes in Pho Chhu Sub basin - 2 Activities 3. Measurement of glacier ice thickness on Gangju La - 1 activity
	Hydro met and Flood/GLOF warning network enhanced.	The critical hydro-met/GLOF infrastructures & network enhanced & maintained	Number	5	1. Renovation of Cable way station at Tingtibi & Sed. Lab at Doyagang completed 2. More than 80% of the construction of Site office at Lamozingkha completed but work got delayed due to COVID-19 pandemic. 3. Boundary fencing and water supply work at newly constructed Central regional office in Bumthang and URC land at Punakha, Dagana & Tang completed. 4. Renovation works of the site office at Damphu, Tsirang completed. 5. More than 70% of renovation work at Sherichu, Mongar completed. Work go delayed due to COVID19 pandemic. 6. Maintenance and rehabilitation work of hydro-met stations completed.

	Assessment of hydro-logical hazard conducted.	Assessment of hydrological hazard conducted.	Number	3	1. Hydrological and flood hazard assessment for major river basin and sub basins of (Amo Chhu, Wangchhu (Thim Chhu, Pa Chhu and Haa Chhu), Gamri Chhu under Manas at Sakten conducted. 2. Flood hazard map preparation for settlements along major river basin of Bhutan (Amo Chhu, Thim Chhu, Pa Chhu, Haa Chhu, Gamri Chhu) conducted. 3. Updation of Flood hazard maps of Chamkhar Chhu and Mangde Chhu 4. Flood hazard assessment and mapping of Ammochu at Phuetsholling conducted.
	Flood forecast, GLOF/Flood warning/ advisories issued	Flood forecast, GLOF/Flood warning/ advisories issued.	Number		1. Flood/GLOF Early warning during cyclone AMPHAN issued
Access to hydro logical information and understanding of national water availability improved	Mean Annual Flow of River Basins Generated	Mean annual flow of main river basins generated	number	3	1. Setting up of hydrological modelling and generation of river flow/flood information for dissemination for the sub-basins of Amo Chhu conducted. 2. Develop the river flow forecasting system for Amo Chhu, with 3 days lead time flow forecast issued. 3. Hydrological Data Processor and archived in the Database Management and data disseminated based on the user requests.
	Monitoring and Transmission of hydromet data	Monitoring and Transmission of hydro-met data to HQ	Days		1. Timely monitoring, data observation by Site staffs conducted and data transmit timely to Head Quarter for data processing and archival in National Database; 2. Data from Automatic Weather and Water Level Station transmitted to HQ.

8. Summary of Financial Statement

8.1. Budget Appropriation Past three years

The total budget allocated (RGoB + Donors) to the Center for last three years and expenditure for the FY 2019-2020 are shown in the table 5 and table 6 respectively.

Table 5: NCHM Financial Summary in millions

Sl. No	Funding	NCHM		
		2016-2017	2017-2018	2019-2020
1	RGoB	55.0	76.87	110.063
2	Donors (GOI, World Bank, GCF, PHPA, etc.)	250.6	117.93	64.290
	Total	**305.6**	**194.80**	**170.353**

8.2. Financial Summary for the FY 2019-2020

Table 6: Expenditures during FY 2019-2020

Sl. No	Funding	2019-2020		Budget Utilization in Percentage
		Approved	Expenditure	
1	RGoB	60.290	38.919	83.5%
2	Donors (GoI, World Bank, GCF, PHPA and others)	110.063	103.891	
	Total	**170.353**	**142.259**	

9. Highlights of Climate Status in Bhutan for the year 2019

9.1. Annual rainfall

The annual average rainfall (area average) was 1825.2 mm in 2019. The country as a whole received near-normal rainfall with most of the regions receiving rainfall slightly above the long term average. The highest 24-hour rainfall was recorded at Bhur with 330 mm. Gasa experienced the highest number of rainy days with 174 days (rainy days is defined as rainfall greater than or equal to 1mm). It is to be noted that a greater number of rainy days does not translate to more rain. However, the highest total annual rainfall was recorded at Phuentsholing with 5463.6mm followed by Sipsoo with 5266.6mm.

9.2. Maximum and minimum temperature

The annual average maximum temperature was 22.4°C and minimum temperature was 11.8°C. The highest daily maximum temperature was recorded at Tangmachu with 38.5oC and the lowest daily minimum temperature was recorded at Haa with -11.5oC. Haa experienced a greater number of days with the minimum temperature below or equal to zero with 121 days (minimum temperature <=0).

9.3. Monsoon 2019

Bhutan experiences monsoon from June to September. Bhutan receives most of its annual rainfall during summer monsoon. Thus, it is one of the predominant seasons of the year that influences much of the climate in Bhutan.

9.4. Rainfall

In the summer of 2019, the country as a whole received near-normal rainfall. However, during July and August, most of the stations received slightly above-normal rainfall.

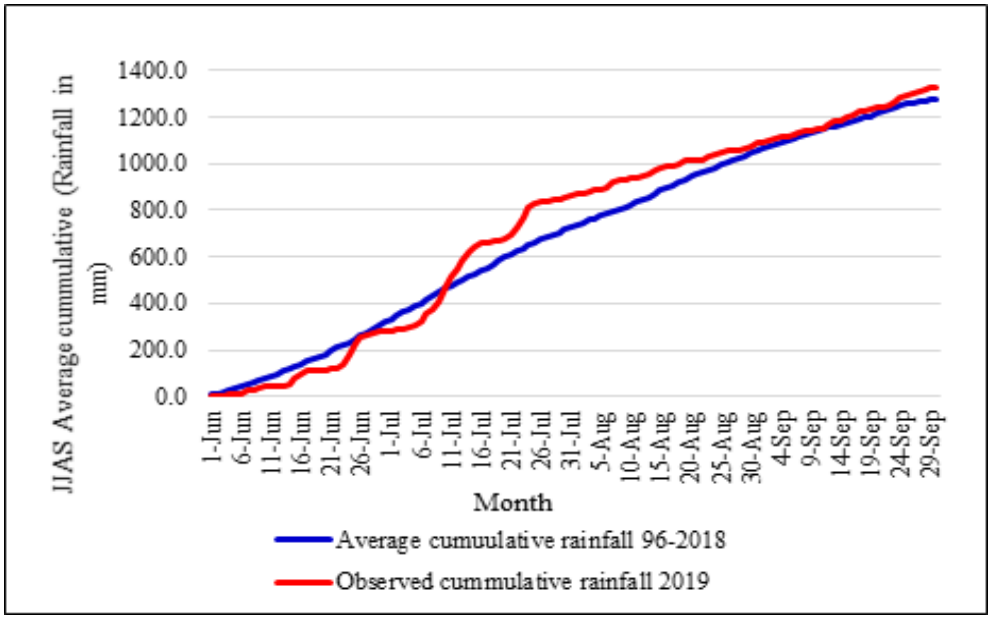


Figure 4: Comparison of observed rainfall of 2019 (JJAS) with long term average (1996-2018).

9.5. Temperature

In the summer of 2019, the country as a whole received near-normal temperature.

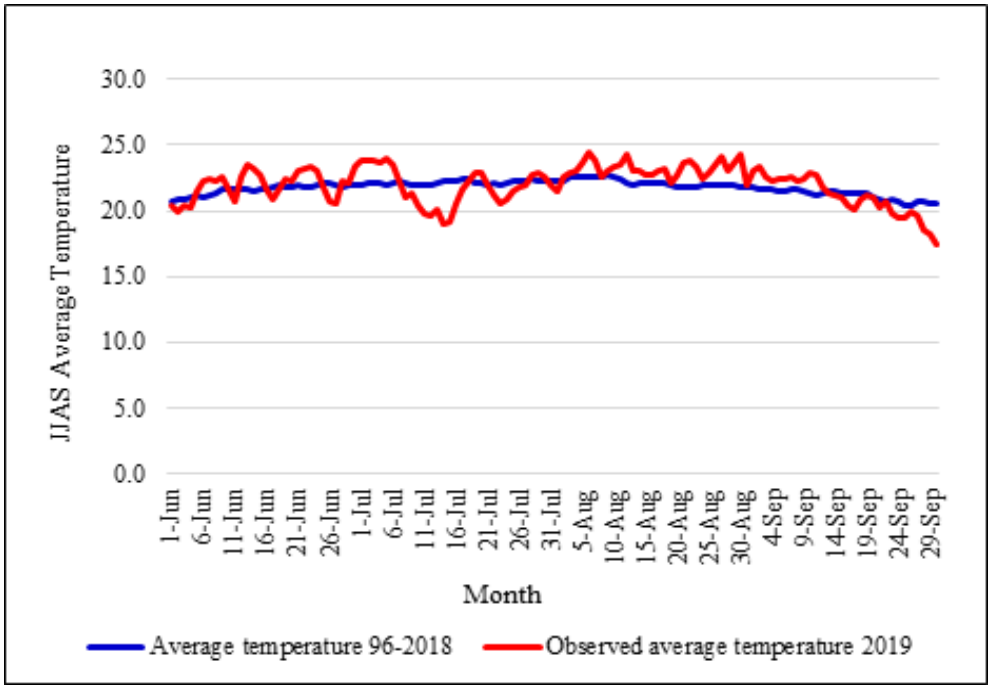


Figure 5: Comparison of observed average temperature of 2019 (JJAS) with long term average (1996-2018

10. Highlights of Hydrology and River flow in Bhutan for the Year 2019

10.1. River Flow Status of Bhutan

The annual average flow of 26 years (1992-2018) are compared with the average flow of 2019 for five principle hydrological stations. Each station is located in different basins but does not serve as a representative flow of the entire basin.

Table 7: Average flow of 26 years (1992-2018) and 2019 annual average flow of five principle hydrological stations

Sl. No	Station Name	Basin/sub-basin	Average Flow (1992-2018)	Average Flow 2019
1	Lungtenphu on Wangchhu	Wangchhu	22.07	17.29
2	Wangdirapid on Punatsangchhu	Punatsangchhu	294.19	278.48
3	Bjizam on Mangdechhu	Manas	63.23	59.68
4	Kurjey on Chamkharchhu	Manas	53.99	49.43
5	Muktirap on Kholongchhu	Manas	64.22	58.10

The average flow of all the stations under consideration for the year 2019 show slightly below the annual average of the past 26 years.

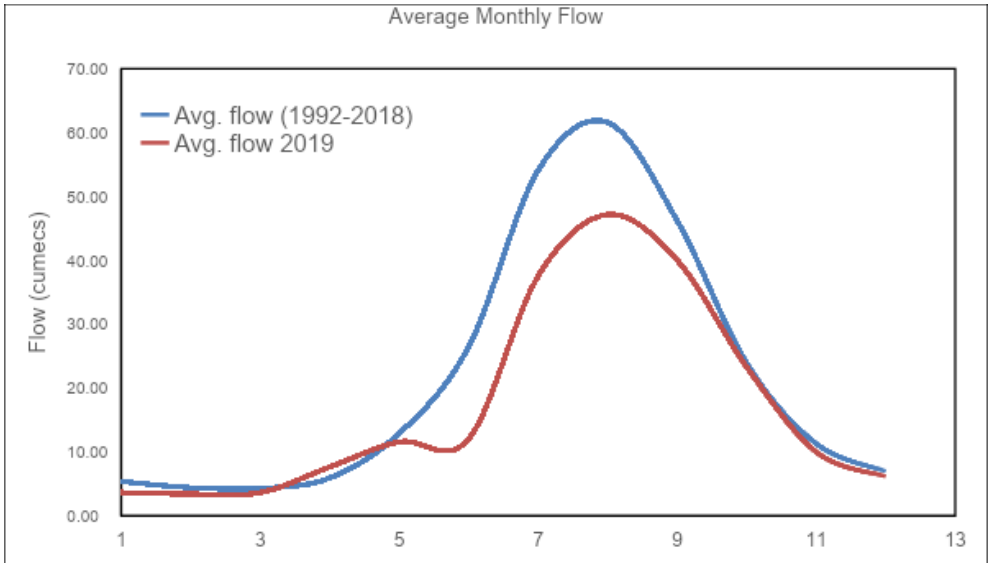


Figure 6: Average Monthly flow hydrograph of Lungtenpgu Station

Highlights of FY 2019-2020 Accomplishments

11. End-to-End Operational of National Framework for Climate Services (NFCS)

The Weather and Climate Services Division of the Center is responsible for climate data processing and analysis (Climate Database Management) and dissemination, to study and provide public weather services, severe weather warnings, aviation and agrometeorological services and climate change information and services.

11.1. Weather Forecast UpdatesThe Weather Forecasting Room (WFC) under the National Weather and Flood Warning Center (NWFWC), Thimphu operates 24/7 and monitors weather conditions around all the 20 Dzongkhag. WFC of WCSD of the Center issues daily weather forecasts that are disseminated through Bhutan Broadcasting Television (TV), Radio and other printed media. Based on severity of weather the Center also issues weather advisories and weather updates from time to time. The daily short-range forecast for the 20 Dzongkhag includes precipitation outlook with maximum and minimum temperature. In addition, social media such as Facebook (https://www.facebook.com/NationalCenterforHydrologyandMeteorology/) are being extensively used by the Center for timely dissemination of information. The Center also provides special weather forecasts based on the users needs and requirements.

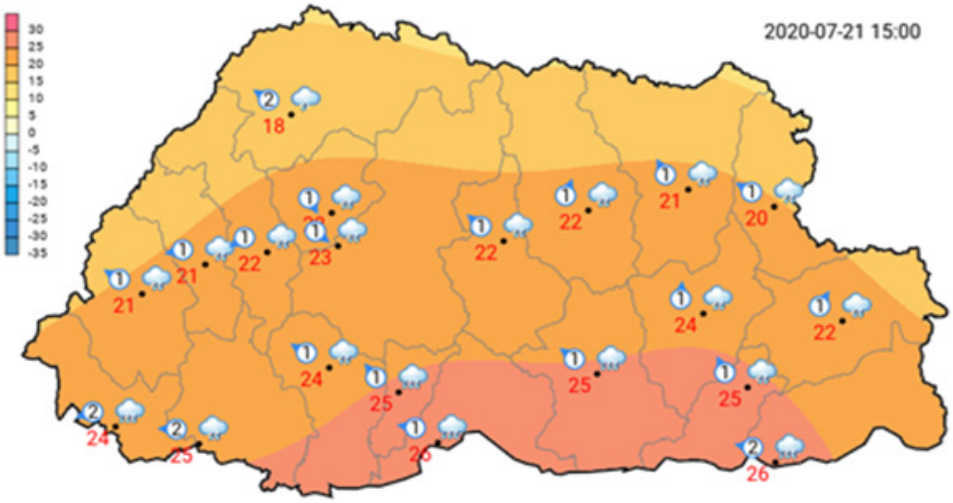


Figure 7: Map showing forecast for all Dzongkhag

11.2. Climate Data and Information Services

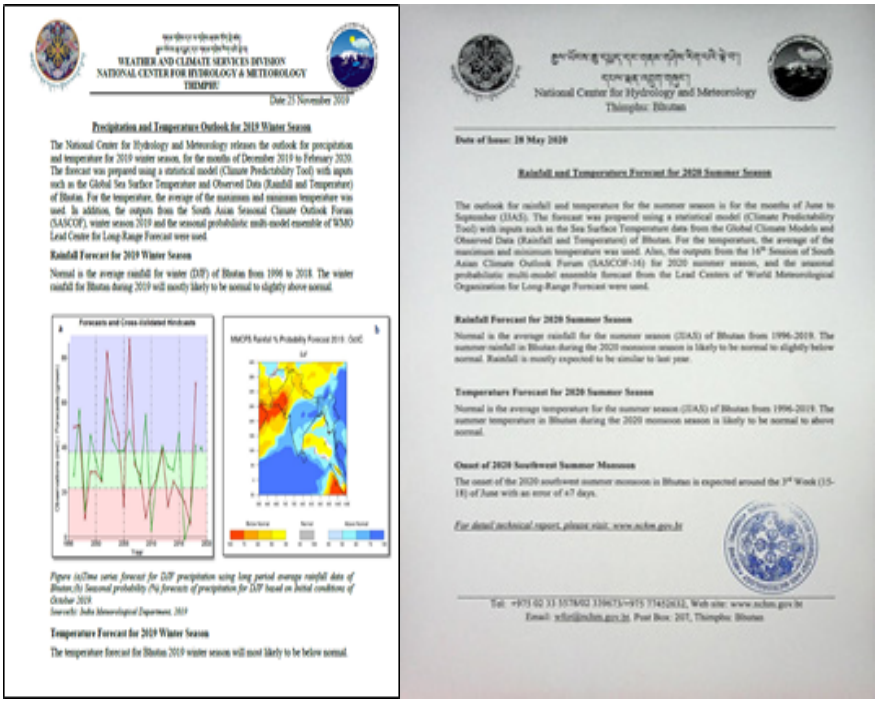
The Center maintains the national climate database management system and provides climate data and related information and services including Climate data processing, quality control, analysis and archival. The data are provided to user sectors and individuals as per their request. The Center produced monthly and annual climate monitoring reports and seasonal forecasts. The center also publishes papers on climate related research studies.

11.3. National Climate Outlook Forum (NCOF-6)

The Sixth National Climate Outlook Forum (NCOF-6) was held on 26th May, 2020 at Center, Thimphu. This forum was established in 2015 as part of the World Meteorological Organization's (WMO) Global Framework for Climate Services (GFCS) for guiding the development and application of climate information in decision-making in climate-sensitive sectors. NCOF is one of the main annual programs of the Center, where seasonal outlook for monsoon are discussed and issued with key stakeholders.

11.4. Winter Monsoon Outlook 2019 and Summer Monsoon Outlook 2020

Center released the outlook for 2019 Winter Monsoon (December, January, February) and 2020 Summer Monsoon (June, July, August and September). The outlook was prepared using a statistical model (Climate Predictability Tool) with inputs such as the Global Sea Surface Temperature and Observed Data (Rainfall) of Bhutan. In addition, the outputs from the 15th and 16th South Asian Seasonal Climate Outlook Forum (SASCOF-15 and 16) and the seasonal probabilistic multi-model ensemble of WMO Lead Centre for Long Range Forecast were used. The Center predicted that the winter rainfall for Bhutan during 2019 would most likely be normal to slightly above normal and the temperature would most likely be below normal. The summer rainfall in Bhutan during the 2020 monsoon season would likely be normal to slightly below normal and temperature to be normal to above normal.



WEATHER AND CLIMATE SERVICES DIVISION
NATIONAL CENTER FOR HYDROLOGY & METEOROLOGY
THIMPHU

Date:25 November 2019

Precipitation and Temperature Outlook for 2019 Winter Season

The National Center for Hydrology and Meteorology releases the outlook for precipitation and temperature for 2019 winter season, for the months of December 2019 to February 2020. The forecast was prepared using a statistical model (Climate Predictability Tool) with inputs such as the Global Sea Surface Temperature and Observed Data (Rainfall and Temperature) of Bhutan. For the temperature, the average of the maximum and minimum temperature was used. In addition, the outputs from the South Asian Seasonal Climate Outlook Forum (SASCOF), winter season 2019 and the seasonal probabilistic multi-model ensemble of WMO Lead Centre for Long-Range Forecast were used.

Rainfall Forecast for 2019 Winter Season

Normal is the average rainfall for winter (DJF) of Bhutan from 1996 to 2018. The winter rainfall for Bhutan during 2019 will mostly likely to be normal to slightly above normal.

Figure (a)Time series forecast for DJF precipitation using long period average rainfall data of Bhutan,(b) Seasonal probability (%) forecasts of precipitation for DJF based on Initial conditions of October 2019.
Source(s): India Meteorological Department, 2019

Temperature Forecast for 2019 Winter Season

The temperature forecast for Bhutan 2019 winter season will most likely to be below normal.

National Center for Hydrology and Meteorology
Thimphu: Bhutan

Date of Issue: 18 May 2020

Rainfall and Temperature Forecast for 2020 Summer Season

The outlook for rainfall and temperature for the summer season is for the months of June to September (JJAS). The forecast was prepared using a statistical model (Climate Predictability Tool) with inputs such as the Sea Surface Temperature data from the Global Climate Models and Observed Data (Rainfall and Temperature) of Bhutan. For the temperature, the average of the maximum and minimum temperature was used. Also, the outputs from the 16th Session of South Asian Climate Outlook Forum (SASCOF-16) for 2020 summer season, and the seasonal probabilistic multi-model ensemble forecast from the Lead Centers of World Meteorological Organization for Long-Range Forecast were used.

Rainfall Forecast for 2020 Summer Season

Normal is the average rainfall for the summer season (JJAS) of Bhutan from 1996-2019. The summer rainfall in Bhutan during the 2020 monsoon season is likely to be normal to slightly below normal. Rainfall is mostly expected to be similar to last year.

Temperature Forecast for 2020 Summer Season

Normal is the average temperature for the summer season (JJAS) of Bhutan from 1996-2019. The summer temperature in Bhutan during the 2020 monsoon season is likely to be normal to above normal.

Onset of 2020 Southwest Summer Monsoon

The onset of the 2020 southwest summer monsoon in Bhutan is expected around the 3rd Week (15-18) of June with an error of ±7 days.

For detail technical report, please visit www.nchm.gov.bt

Tel: +975 02 33 3578/02 3396751/+975 17412632, Web site: www.nchm.gov.bt
Email: wfor@nchm.gov.bt, Post Box: 207, Thimphu: Bhutan

Figure 8: Outlook released for Winter Monsoon 2019 and Summer Monsoon 2020

11.5. Data Dissemination of Meteorological Data to Users

The Center provides meteorological data to Government agencies, private sector, academic researchers and students, corporate sector, foreign institute and others based on the request.

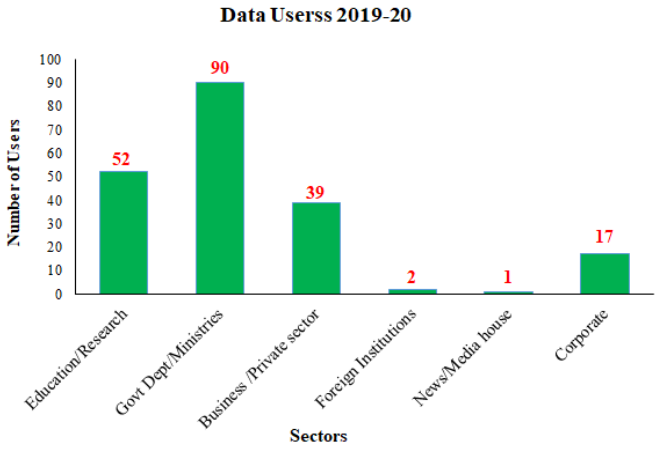


Figure 9: Data users for 2019-20

12. Agro-meteorological services

12.1. Sensitization workshop

The NCHM in collaboration with the Department of Agriculture, MoAF conducted sensitization workshops on the use of weather and climate information on agriculture planning and management at 1) Samtenling ARDC, Sarpang, 2) Bajo ARDC, Wangdue and 3) Wengkhar, ARDC, Mongar around October to November 2019. The NCHM provided technical support and climate information for the development of Agro-meteorological services. The Center collaborates and closely works with DoA to improve the agro-meteorological services in Bhutan.

The activity was funded by Food and Agriculture Organization (FAO).

Figure 10 : Samtenling ARDC (left) and Bajo ARDC (right)

Figure 11: Wengkhar ARDC

12.2. Regional review and planning workshop

The Agro-meteorology Program of the Department of Agriculture in collaboration with National Center for Hydrology and Meteorology (NCHM) participated in the Regional Review and Planning Workshop in Agriculture Research and Development Centre, Bajo on 30 December 2019. NCHM sensitized the participants from different ARDC's and client dzongkhag of the west central region on weather and climate services provided by the Center and use of agro-met decision support system. The program was funded by the Food and Agriculture Organization (FAO).

Figure 12: Program participants

13. Aviation Meteorological Services

Bhutan Civil Aviation Authority (BCAA) designated NCHM as the Aeronautical Meteorological Service Provider (AMSP) within Bhutan as per the Civil Aviation Act of Bhutan 2016. It provides aviation meteorological services for air traffic management (ATM) services for air navigation in accordance with Bhutan Civil Aviation Authority (BCAA) and International Civil Aviation Organization (ICAO) legal requirements. The Aviation Meteorological Section under the Weather and Climate Services Division (WCSD) operates from the Paro International Airport. Paro International Airport and all the three domestic airports located at Bumthang, Gelephug and Yonghula have the Aviation Meteorological Office established with required manpower.

13.1. Maintenance of Airport Water Stations

Timely inspection and maintenance of meteorological instruments for observation and monitoring of weather parameters at airports such as: air and dew point temperature, wind speed and direction, atmospheric pressure, cloud coverage and ceiling, and telecommunication networks is very important for operation and safety of domestic and international flights. Running and maintenance of airport weather stations and associated communication systems were successfully completed as per the SOP detail as given in the Table 8.

Table 8: Shows the details of ad hoc maintenance carried out at the airport stations for the FY 2019-2020:

Date	Airport Name	Details of maintenance work carried out
21-31 Aug 2019	All airports	Half-yearly station inspection to check and access the requirements for standards for quality aviation met services
22-28 Nov 2019	Yongphula domestic airport	Replaced all the sensors and configuration file updated
29 Oct – 01 Nov 2019	Bumthang domestic airport	Replaced all the sensors and configuration file updated

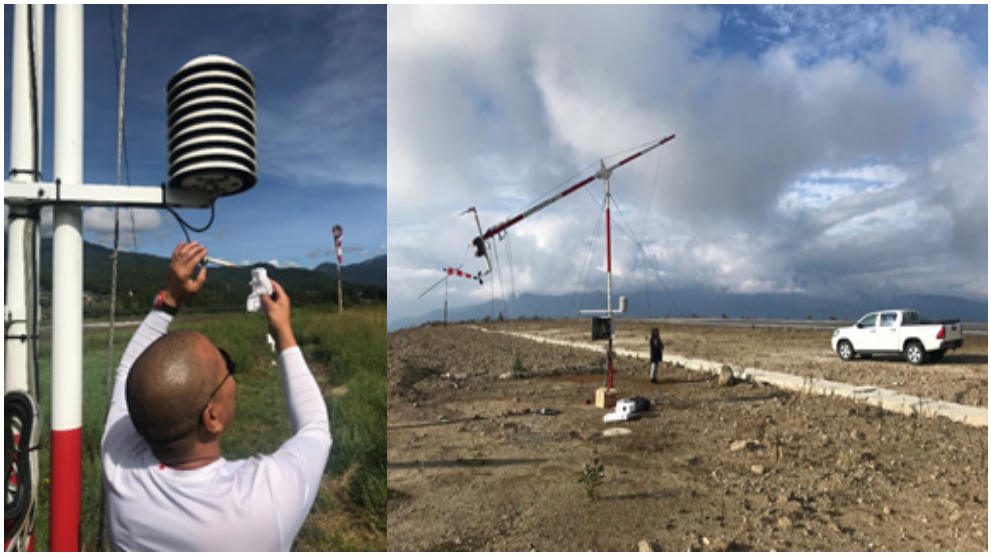


Figure 13: Cleaning of air temperature sensor (left) and replacing sensors of Yongphula AWOS (right)

14. Hydrology and Water Resources Services

Hydrology and Water Resources Services Division (HWRSD) of the Center is responsible for Research and carryout water resources assessment, hydrological forecasting, hydrological data management, dissemination of hydrological data and information and provide early warning services related to flood and GLOF including assessment and mapping of hydro-meteorological and GLOF hazards at the sub-basin and basin level.

14.1. Hydrological Database Management

The Center maintains the national hydrological and sediment database management system and provides hydrological data and related climate information and services including hydrological data processing, quality control, analysis and archival. The data are provided to user sectors and individuals as per their request. The Center produced monthly and annual outlook and published a Hydrological Databook.

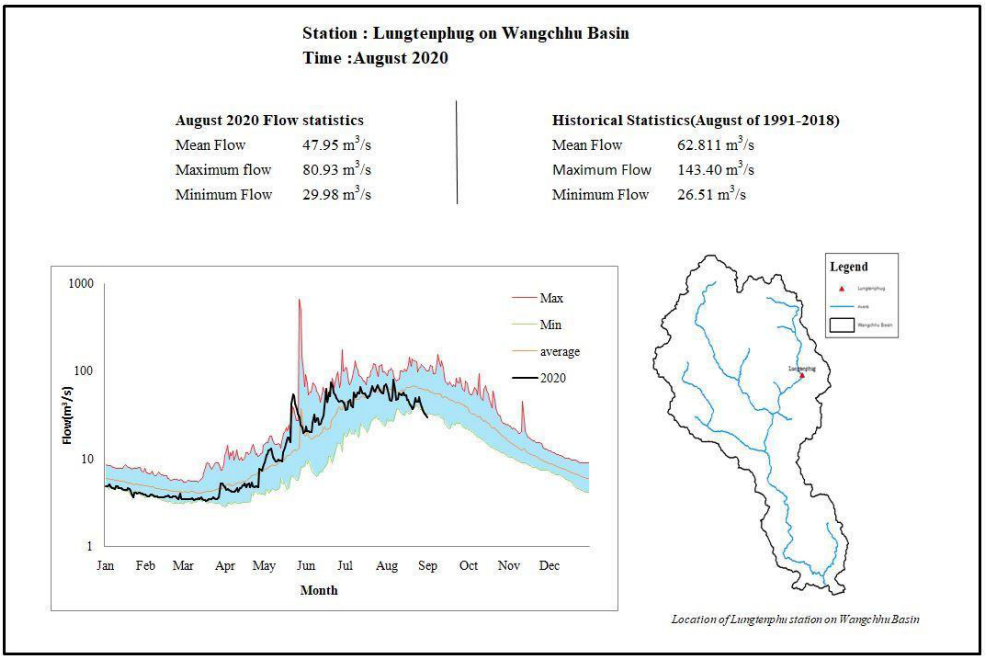


Figure 14: Monthly Flow Outlook

14.2. Data Dissemination of Hydrological Data to Users

The Center also provides Hydrological data to Government agencies, private sector, academic researchers and students, corporate sector and others private as per the request as per the "Guidelines on the Exchange and Dissemination of Hydro-meteorological Data and Information"

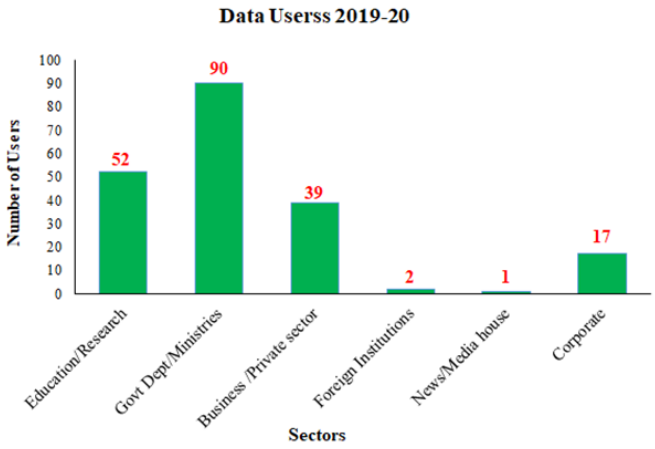


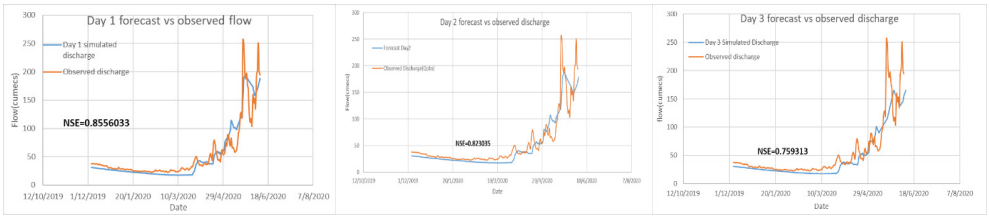
Figure 15: Data users for 2019-2020

14.3. Hydrological Modelling, Mapping and Flood Forecasting Services

14.3.1. Re-calibration and Validation of Yebesa hydrological Model (HBV)

An HBV hydrological model has been piloted and operational since 2016 at Yebesa on Mochhu, the model provides a 3-day forecast of river flow. The semi-distributed model was re-calibrated every year to improve accuracy and performance of the model. The recalibration resulted in a slight improvement of model performance than before.

The model also provides 3-day flow forecasts and its validation results shown below:



Yebesa flow forecasting system on Mochu sub-basin shows good performance in simulating the river discharge at accuracy level of 78% (NSE=0.78) with forecast accuracy of 85.56%, 82.3% and 76.36% for Day 1, Day 2 and Day 3 respectively. The model will be used for inflow and flood forecasting for water resources management.

14.3.2. Set up of HBV hydrological model in Amochu basin

An Interim Community based Flood Early Warning System for Ammochhu Settlement was set up to warn communities (evacuated from Jaigoan) who were resettled in the shelters constructed at bank of Ammochh at Phuentsholling Township Development Plan (PTDP) in May 2020. To supplement the Flood EWS a pilot HBV Hydrological forecasting model was set up to provide a 3-day flow forecast that was being used as a guidance by the Flood EWS Control Room established at Phuentsholling. Re-calibration of the model shall be carried out from time to time to improve accuracy.

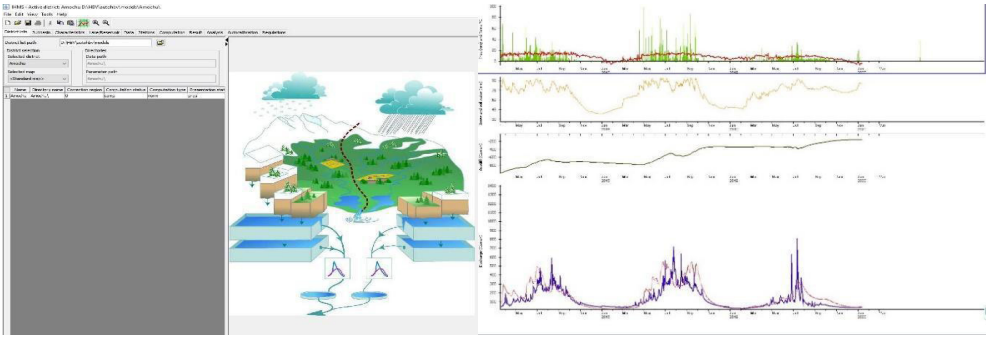


Figure 16: HBV model set up for Amochu basin

14.3.3. Waterline Survey and Pre-feasibility fir installation Flood Early Warning System in Pachu sub-basin

A water line survey and pre-feasibility study for the installation of GLOF/Flood EWS in Haachu and Thimchu sub-basins was carried out during the FY 2018-19. A similar study was carried out for Pachu sub-basin in FY 2019-2020. The activity includes visual inspection of lakes in the headwaters, discharge measurement, waterline survey and preliminary site selection for installation of automatic water level stations.

Figure 17: Pre-feasibility study for installation of GLOF/EWS

14.3.4. Flood Hazard Assessment and Mapping

The flood hazard assessment and mapping for the Gamrichhu at Sakteng and Ammochhu at Phuenstholling was carried out during the FY 2019-2020.

14.3.5. Flood Hazard mapping of Gamrichhu at Sakteng

Figure 18: Flood hazard assessment and Mapping for Gamri at Sakteng.

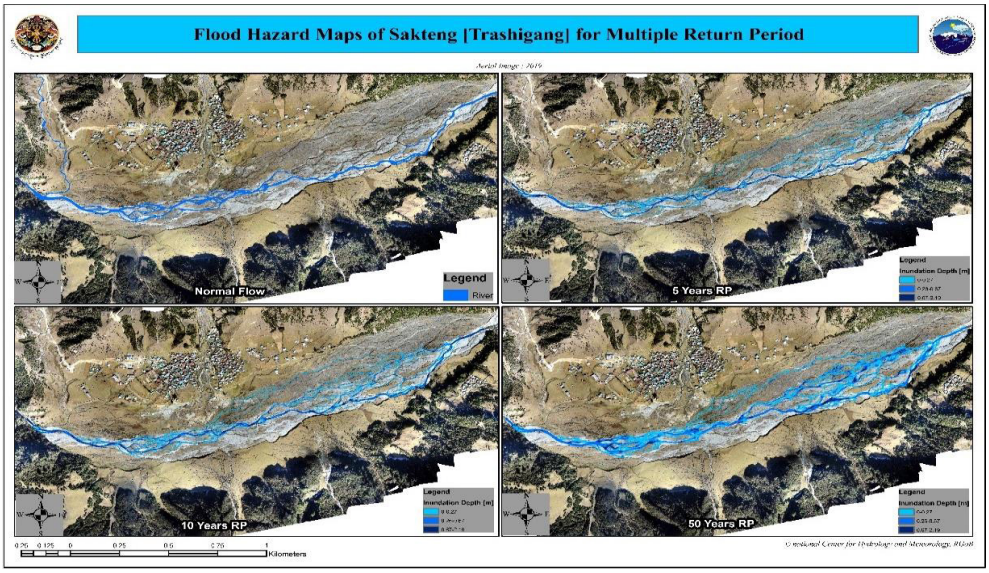


Figure 19: Flood Hazard Map of Gamri at Sakteng of different return period.

14.3.6. Aerial Survey and Flood Hazard Mapping of Ammochhu

The flood hazard map for Ammochhu at Phuentsholling developed in February 2017 and updated (2020) was required due to recent development and activities in the area.

The historical flood information and latest drone survey generated DEM map (2020) was used for assessment and generation of flood hazard maps of Ammochu bank settlements area including the inundation map of the area. Inundation maps was generated based on the flood frequency analysis for different return periods (Figure 21). Inundation maps of different returns periods are used to determine the warning levels.

Flood hazard maps are used for identifying the evacuation sites and routes to be used for flood disaster preparedness and response.

Figure 20: Aerial Survey by Drone (22-23 April 2020) of Ammochhu

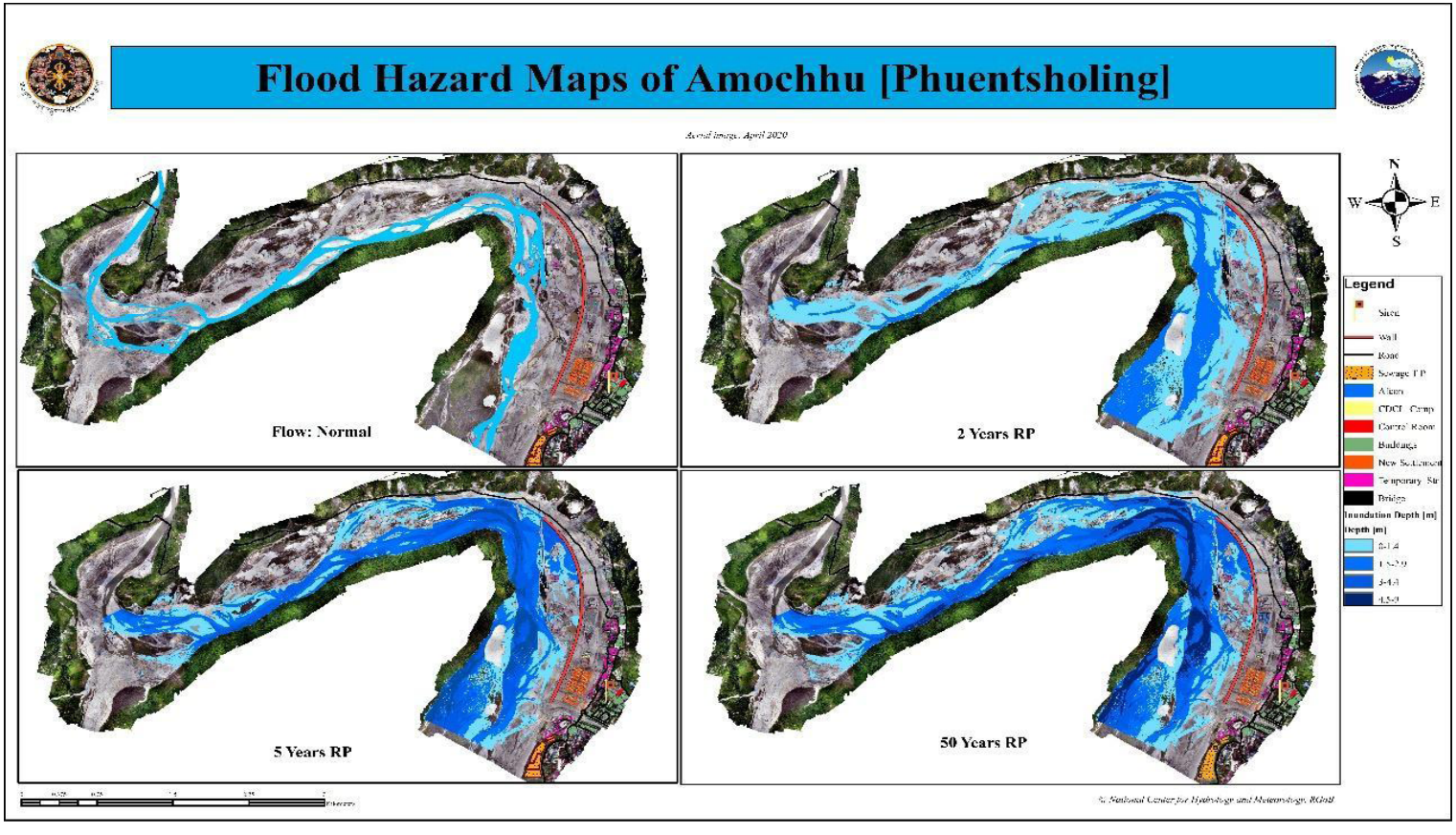


Figure 21: Flood hazard maps for different return periods for Ammochhu

15. National Hydro-met Observation Network

15.1. Annual Maintenance of Hydro-Met Observation Network

The Center operates and maintains a national hydro-met observational network that consists of more than 250 stations covering all Bhutan. The National hydro-met network includes the following:

a. Meteorological Station network
b. Hydrological network
c. Flood/GLOF EWS
d. Flood Warning network supported by GoI.

Table 9:Types of monitoring stations

Sl No	Type of Monitoring Station	Number
1.	Meteorology/Climate Station	171
2.	Cryosphere (Snow and Glaciers) monitoring Stations	26
3.	Hydrological/Flood Observation Stations	74
4.	Sediment Sampling Stations	16
	Total	**287**

Annual maintenance works for the national hydro-met observation network completed and all the stations operation detailed shown in the table 9.

Table 10: List of stations maintenance in 2019-2020

Sl No	Station Category	Station Type	Total Maintenance in 2018-2019 FY	Total Maintenance in 2019-2020FY
1	GLOF -EWS	Automatic	15	15
2	Hydrological Stations	Manual	19	19
3	Hydrological Stations	Automatic	30	42
4	Meteorological Stations	Manual	20	20
5	Meteorological Stations	Automatic	77	82

Center also completed annual lean flow measurement of the 60 un-guaged streams covering the whole country.

Figure 22: Photos of Annual Maintenance of Hydro-Met Stations

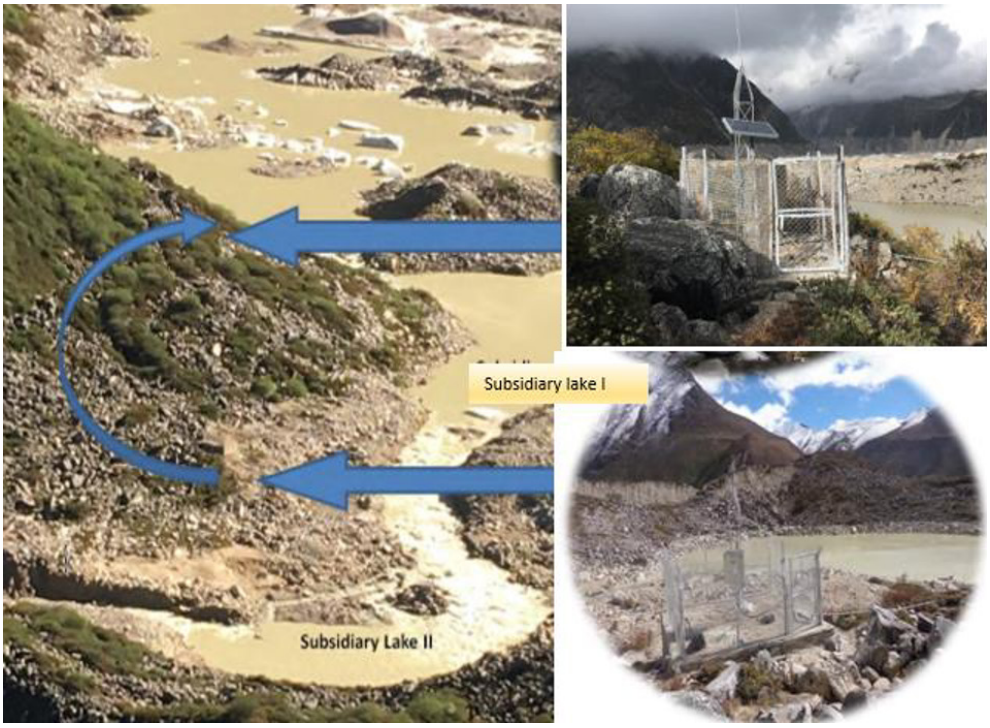


Figure 23: Rehabilitation of AWLS station at Thorthormi Lake out-let.

15.2. Maintenance of Flood/GLOF /Early Warning Systems

NCHM currently operates three Flood/GLOF EWS in Punatsangchhu, Mangdechhu and Chamkarchhu basin. After procuring necessary spare parts the maintenance of all the flood and weather monitoring stations, warning sirens, communication and Control Room equipment were completed based on the operation and maintenance manuals and SOPs for all three systems.

Maintenance team also restored Thorthormi lake and Thanza AWLS damaged by 20 June 2019 GLOF occurred due to breach of Thorthmi lake Subsidiary lake-II.

15.3. Construction of Site Office and related Civil works

During the FY 2019-2020, the HOID carried out the following construction and related civil works to enhance NCHM service delivery.

15.3.1. Hydrological Site office and Sediment lab

Based on the 12 FYP plan, a Hydrological Site Office and Sediment lab was constructed at Karmaling, Karmaling Gewog, Lhamozingkha Dungkhag,Dagana Dzongkhag under RGoB funding. RGoB. However, the work was hampered by COVID19 pandemic and the activity has been spilled over to FY 2020-21. More than 50% of the work has been completed by the end of June 2020.

Figure 24:Sediment Lab at Karmaling during construction

15.3.2. Maintenance of Site office at Damphu and Sherichhu.

Based on the 12 FYP plan, maintenance of three site offices viz. Damphu, Tsirang, Doyagang, Chhukha and Sherichhu, Mongar carried out under RGoB funding. The maintenance work of Sherichhu Mongar was hampered by COVID19 pandemic and the activity has been spilled over to FY 2020-21.

Fig 25.1: Maintenance of Site Office at Damphu

Fig 25.2: Doyagang Site office

15.3.3. Boundary Fencing of Dagapela, Tang and Lekithang AWS.

Based on the 12 FYP plan, boundary fencing for the land of three hydromet stations viz. Dagapela, Tang and Lekithang has been carried out under RGoB funding. The boundary fencing of Tang was hampered by COVID19 pandemic and the activity has been spilled over to FY 2020-21.

15.3.4. Maintenance of Cableway Stations at Doksum and Tingtibi

Based on the 12 FYP plan, cableway stations at Doksum and Tingtibi were maintained under the RGoB funding. The maintenance work of Doksum was hampered by COVID19 pandemic and the activity has been spilled over to FY 2020-21.

15.3.5. Retaining Wall Construction at Trashiyantse

Based on the 12 FYP plan, retaining wall construction at Trashiyangtse Principle River Gauging Station has been constructed under the RGoB funding.

Fig 26: Fencing at Lekithang AWS, Punakha.

Fig 27: Retaining wall at Trashiyangtse

15.4. Installation/Upgradation of Hydro-met Stations

Two Automatic Water Level Stations at Doyagang and Dorokha on Amochhu were installed as part of the Interim Flood Early Warning System for the Amochhu Basin. The center also upgraded the Automatic Weather Station (AWS) located at College of Science and Technology (CST), Phuentsholing and Class C met station was installed at Doyagang Site Office.

Figure 28.1: New Automatic Water Level Stations at Doyagang

Figure 28.2: Manual Guage at Doyagang

16. Cryosphere Monitoring and Services

Highlights of Accomplishments for the FY 2019-2020

16.1. Annual Monitoring of Benchmark Glaciers

Throughout the globe, in most of the glacierized alpine and high altitude regions, glaciers are retreating at an alarming rate that is attributed to the ongoing global climate change (Emmer, 2019). Glacier retreat is connected to various interrelated geomorphological, hydrological processes, and changes in hydrological regimes driven by the recent Global Climate Change.

Since there is not much data and information on Bhutan glacial regime, the Center has established two long term Benchmark glaciers in Bhutan for annual monitoring, viz., Gangju La glacier in the headwater of Pho Chhu Sub-basin and Thana glacier in the headwater of Chamkhar Chhu Sub-basin.

The Cryosphere Services Division (CSD) also conducted glacier mass balance studies on benchmark glaciers. The summaries on glacier mass balance studies are described below.

16.1.1. Gangju La glacier

Gangju La Glacier is located in the Northern frontier of Bhutan at 27.94^0N, 89.95^0E in the headwater of Pho Chhu Sub-basin with an approximate area of 0.215 km^2. This clean ice glacier extends from elevation of 4900 to 5200 m.a.s.l.

The field activity was carried out from September 20, 2020 to November 1, 2019. In the glacio-hydrological year 2019-2020 (Autumn Net Balance), Gangju La Glacier revealed a negative glacier mass loss as the terminus has retreated as well. The detailed methodologies, data processing, results, and recommendations are compiled in the "Scientific Report on Gangju La Glacier 2019-2020".

16.1.2. Thana Glacier

Thana Glacier is located in the north-central part of the Bhutan Himalayas in the headwater of Chamkhar Chhu and is oriented Southeast at 28.021°N and 90.607°E (Fig. 3) with a surface area of approximately 3.77 km^2.

The field work was carried out from August 14, 2019 to September 4, 2019. The detailed methodologies, data processing, results, and recommendations are compiled in the "Scientific Report on Thana Glacier 2019-2020".

16.2. Ice Thickness Studies on Gangju La Glacier

During the FY 2019-2020, the CSD team successfully conducted the Ice Thickness studies on Gangju La Glacier using the Ice Penetrating Radar (IPR). The team was in the field from September 20, 2020 to November 1, 2019. The detailed methodologies, data processing, results, and recommendations are compiled in the technical report "Ice Thickness Studies on Gangju La Glacier 2019-2020".

16.3. Time Series Monitoring of Glacial Lake in the Headwater of Pho Chhu subbasin.

As a part of planned activities for the FY 2019-2020, a field expedition was conducted in the headwaters of Pho Chhu in September 2019. A team collected lake Bathymetry data and other information for assessing the potential hazard and threat of the lake to downstream. The team was in the field from September 20, 2020 to November 1, 2019. The detailed methodologies, data processing, results, and recommendations are compiled in the "Time Series Monitoring of Wachey Glacial Lake GLT 6.5 in the Headwater of Pho-Chhu September 2019-20".

16.4. Time Series Monitoring of Wachey Glacier in the headwater of Pho Chhu subbasin.

The field expedition for the FY 2019-2020 was deputed to the head water of Pochhu from September 20, 2019 to November 1, 2019. Team conducted a bathymetry survey of lakes and collected other information to assess the potential risks of the lakes downstream. The detailed methodologies, data processing, results, and recommendations are compiled in the technical report "Time Series Monitoring of Wachey Glacial Lake GLT 6.5 in the Headwater of Pho-Chhu September 2019-2020".

16.5. Ad hoc activity

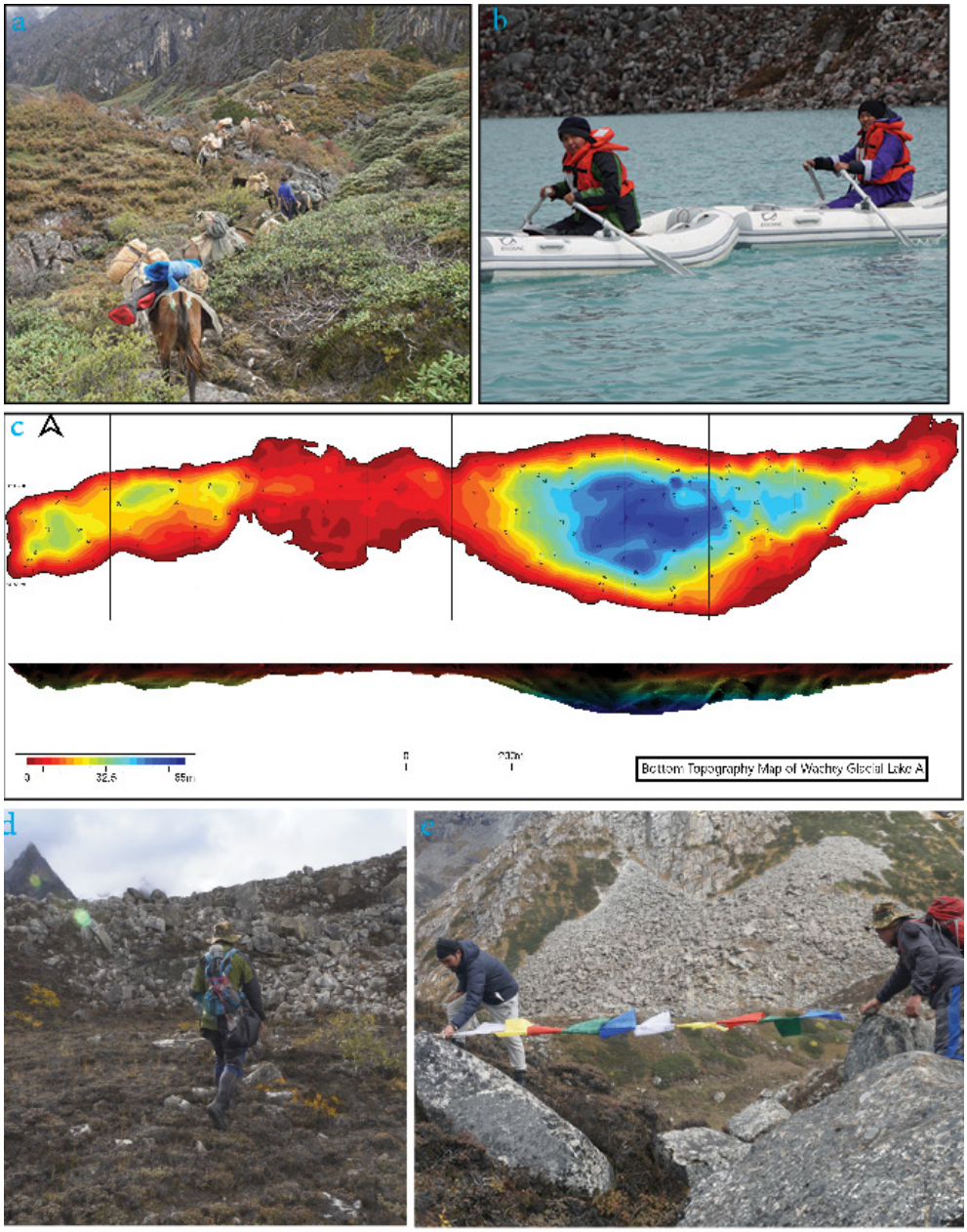
16.5.1. Detail Assessment on the Thorthormi Glacier and Glacial lake

After June 20, 2019, Glacial Lake Outburst Flood (GLOF) from Thorthormi lake the Center with the financial assistance from the Punatshangchu Hydropower Project Authority (PHPA) – I & II, deputed a technical team to carry out a detailed reassessment of Glacier and associated lakes in Lunana from September to October 2019. Team conducted aerial survey of Thothormi lake, a moraine feature surrounding Thorthormi lake, a survey on Luggye glacial lake, and a bathymetry survey on Baychung glacial lake. The detailed methodologies, data processing, results, and recommendations are compiled in the tehcnail report "Detail Assessment Report on GOLF Hazard from Thorthormi Glacial Lake and Associated Glaciers''. The report was presented to the Ministry of Economic Affairs and shared with PHPA-I and II management.

a.Gangju La Glacier 2019
b. differential Global Positioning System (dGPS) survey (rover mode)
c.Heavy snow at the base camp of Gangju La
d.Base Station at Gangju La glacier

a.Gangju LaIce Radar Survey Team
b. Ice Radar Survey by draging the IPR over the glacier
c. Transportation of field equipments on the horse over the Gangju La glacier
d.extracting ice depth data
e. Result of the Ice Penetrating Radar Survey

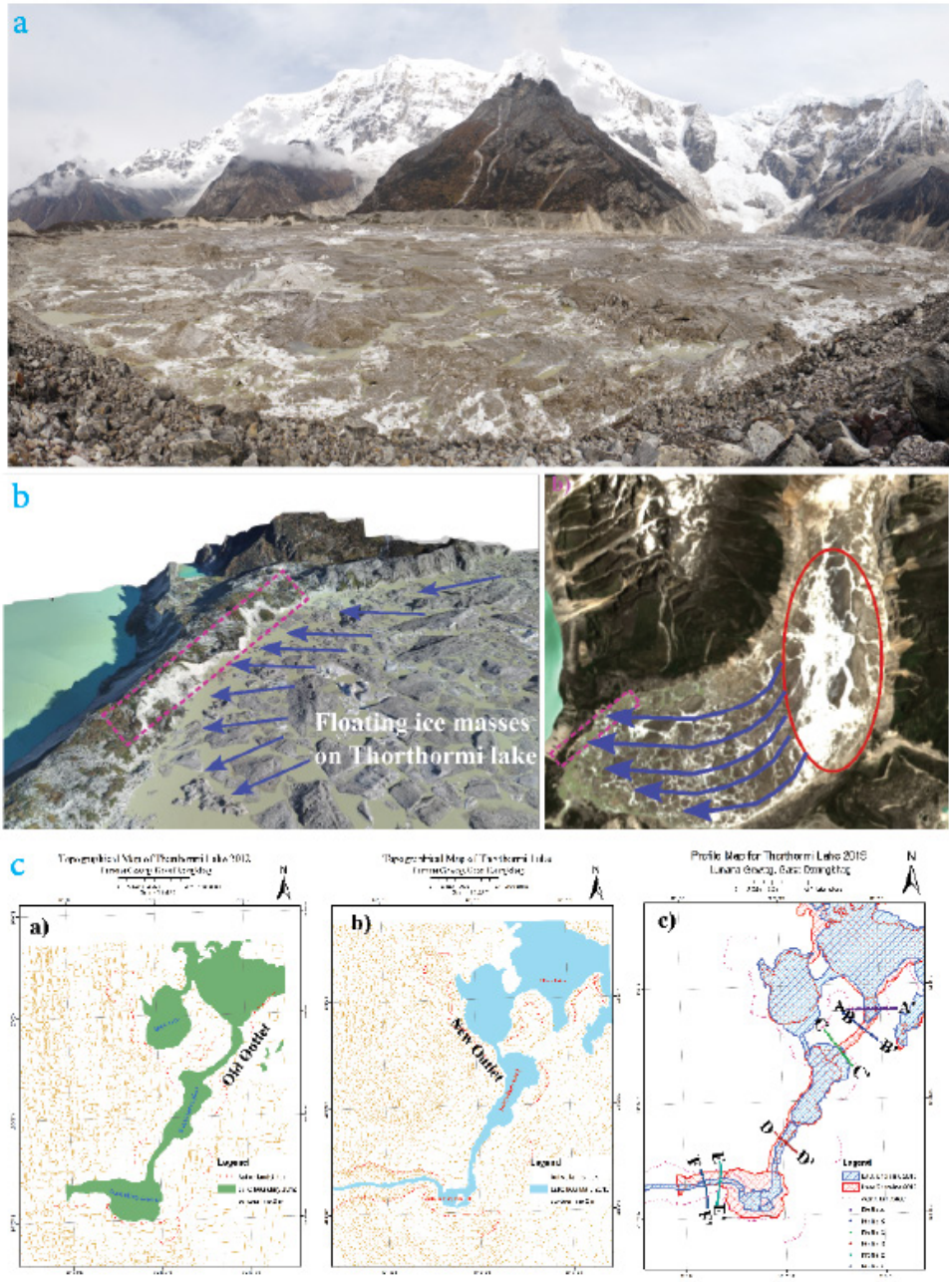
a.Stake Measurement at Thana Glacier 2019
b. Transportation of Field Equipments on horse
c. Panaroma of Thana Glacier 2019
d.Base station near the terminus of Thana Glacier
e. differential Global Positoning System (dGPS) Survey on Thana Glacier



a.Transportation of Field Equipments using horse through rough terrains.
b. Bathymetry Survey of Wachey Glacial lake
c. Bathymetry map of Wachey Glacial lake
d.differential Global Positoning System (dGPS) Survey on moraines of wachey glacial lake
e. Hosting of prayer flag begore the survey.

Figure 29: Aerial Drone Survey and Reassessment of Thorthormi lake after 21 June 2020 GLOF

a.Panaromic view of Lunana Complex (left-Right: Baytsho lake, Rapstreng lake, Thorthormi lake)
b.Unmanned Aircraft System (UAS) survey using eBee plus over the Thorthormi lake
c. Old subsidiary lake II water level mapping using Trimble R-10 2.
d.Lunana site staff learning how to row the inflatable bathymetry boat
e.Testing of Ice Penetrating Radar (IPR) on Luggye Moraine near the outlet.
f. Cheerful Lunana Field Team after sucessful completation of UAS Survey.
g.Bathymetry survey on Baytsho lake.



a.Panaromic View of disintegrated Thorthormi glacier over the lake
b.Schimitic diagram to show how the june 20,2019 mini GLOF occured.
d.Topographical Map of the thorthormi lake.

17. Publications and Reports

The Center provides the scientific and technical data and services related to hydrology, water resources, meteorology, climatology and cryosphere to line agencies. Based on the field works and research the Centre published numerous reports and guidelines during FY 2019-2020. The reports are made accessible on the Center Website page: www.nchm.gov.bt.

The following reports ares published during the FY 2019-2020:

1. Report on the Detailed Assessment of GLOF Hazard from Thorthormi Lake and Associated Glaciers
2. Report on the Installation of Interim Community Based Flood EWS for Ammochhu Settlement
3. Standard Operating Procedure (SOPs) for four divisions of the NCHM
4. Guidelines on the Exchange and Dissemination of Hydrological and Meteorological Data and Information
5. Annual Climate Summary, 2019
6. Weather Research and Forecasting (MRF) Model Verification, 2020 Report
7. Extremes Weather Records

Figure 30: Governing Board Chairperson and Director, NCHM launching of the Center Reports during 5th Governing Board Meeting on 12 June 2020

18. Extreme Events Warning and Advisories

Bhutan observed numbers of the extreme events during the FY 2019-2020. Accordingly, the Center monitored and issued weather and flood advisories and outlook on extreme weather to the general public through national media and social media.

National Center for Hydrology and Meteorology
Thimphu: Bhutan

NCHM/NWFWC/FORECAST-14/2019-20/396

Issue Date: 20th May, 2020
Issue Time: 7:30 PM

Advisory on Cyclone 'AMPHAN'

The cyclone "AMPHAN" completed its landfall by 7:00 PM (BST) as an Extremely Severe Cyclonic Storm. Currently, the cyclone is crossing West Bengal coast Digha and Hatiya Islands, Bangladesh and to the Sundarbans. The system is likely to move North-Northeast. Under this system Bhutan has started experiencing overcast skies and light rainfall .

During the next 48 hours (21-22nd May), moderate rainfall is likely over northern, western and central parts; and moderate to heavy rainfall across southern and eastern parts of the country. Thunderstorms and gusty winds are likely over isolated parts of the country during the same period.

Periodic updates will be issued based on the severity of the system.
For more information please contact +975 335578, +975 339673, +975 77452632, or visit our website www.nchm.gov.bt

National Center for Hydrology and Meteorology
Thimphu

Tel: +975 02 33 5578/02 339673/+975 77452632, Web site: www.nchm.gov.bt
Email: wfcr@nchm.gov.bt, Post Box: 207, Thimphu: Bhutan

National Center for Hydrology and Meteorology
Thimphu: Bhutan

NCHM/NWFWC/FORECAST-14/2019-20/401

Issue Date: 23 May, 2020
Issue Time: 4:00 PM

Advisory on Rainfall

A Western Disturbance lies over the Western Himalayan Region and is moving eastwards. There is moisture feeding to the system from the Bay of Bengal.

Under the influence of the system, moderate to heavy rainfall is likely over southern parts of the country during the next 72 hours (24-26 May). Rest of the places can expect light to moderate rainfall during the same period. Gusty wind is likely over isolated parts of the country.

Due to heavy rainfall, there are possibilities of flash floods/floods and landslides in the isolated areas of southern parts of the country.

Periodic updates will be issued.
For more information please contact +975 335578, +975 339673, +975 77452632, or visit our website www.nchm.gov.bt

National Center for Hydrology and Meteorology
Thimphu

Tel: +975 02 33 5578/02 339673/+975 77452632, Web site: www.nchm.gov.bt
Email: wfcr@nchm.gov.bt, Post Box: 207, Thimphu: Bhutan

Figure 31: Weather Advisory

19. Project

19.1. JICA Technical Cooperation Project

A record of discussion for the new JICA Technical Cooperation Project for Capacity Enhancement of Meteorological Observation, Forecasting and Flood Warning, for Disaster Preparedness and Response in Thimphu and Paro River Basins was signed between GNHC, DDM, NHCM and JICA on 31 October 2019. The project was planned to start from February 2020 but got delayed due to the COVID 19 situation.

19.2. GCF Project

The Center is one of the partner agencies responsible for implementation of the GCF project "Supporting Climate Resilience and Transformational Change in the Agriculture Sector" in Bhutan started from January 2020. The 5 years project is expected to end by 31 December 2025. Out of the total fund of USD 25.4 million, USD 1.7 million is allocated to NCHM to enhance the climate and agromet services.

The project will focus on three main outputs:

- Promote resilient agricultural practices in the face of changing climate patterns.
- Integrate climate change risks into water and land management practices that affect smallholders.
- Reduce the risk and impact of climate change induced landslides during extreme events that disrupt market access.

20. Institutional Linkages and Collaboration

20.1. Internship for College Students

20.1.1. College of Natural Resources, Royal University of Bhutan

Six final year students undertaking B.Sc. Environmental and Climate Studies from the College of Natural Resources (CNR), RUB joined the Center on 3 December 2019 for internship for a period of two months.

Students were placed in four different divisions and undertook the research work on weather, climate, hydrology and water resources.

At the end of internship students presented their work to the Center and they were awarded certificates in participation of successfully completing a two months internship program on 3 February 2020.

Figure 32: Director and Chiefs with Six Interns of CNR, RUB

Figure 33: Interns Presenting their work to the Management

20.1.2. Sherubtse College, Royal University of Bhutan

A Memorandum of Understanding (MOU) was signed between NCHM and Sherubtse College on 15 April 2019 to carry out the joint research work in the field of weather, cryosphere, hydrology and water resources. Four final students studying B.Sc Environmental Science in Sherubtse College, RUB joined the Center on 23 December 2019 for one month internship. Center awarded the certificates of interns for successful completion of internships on January 23, 2020.

Figure 34: Director and Chiefs with Six interns of Sherubtse College, RUB.

21. Institutional Strengthening of Hydro-met Sector

21.1. Hydro-met Policy Formulation

There is no policy and legislation related to operation of Hydro-met services in Bhutan. To formulate a policy a day-long consultation workshop for development of Hydro-met Policy of Bhutan was organised by the Center with financial and technical support through the World Bank. The workshop was held on 1 October 2019 at Ariya Hotel and was attended by officials from relevant stakeholders. The Draft Concept Note of Hydro-met Policy of Bhutan was submitted to GNHC in May 2020. GNHC has submitted to the Cabinet in June 2020.

Figure 35: NCHM stakeholders Workshop on Hydromet policy Concept Note

21.2. Proposal for Institutional Development

After establishment of NCHM as one of the autonomous bodies since August 2016, the Center faced with numerous challenges such as non-alignment of mandates and functions with existing Acts and regulations, additional mandates, mismatch of position, job responsibilities with skills and knowledge, gaps in qualification requirement for weather and flood forecasting, gaps in competency requirement for the position, issues of reporting. A proposal of structure and other changes was submitted to RCSC in April 2020 with the following objectives:

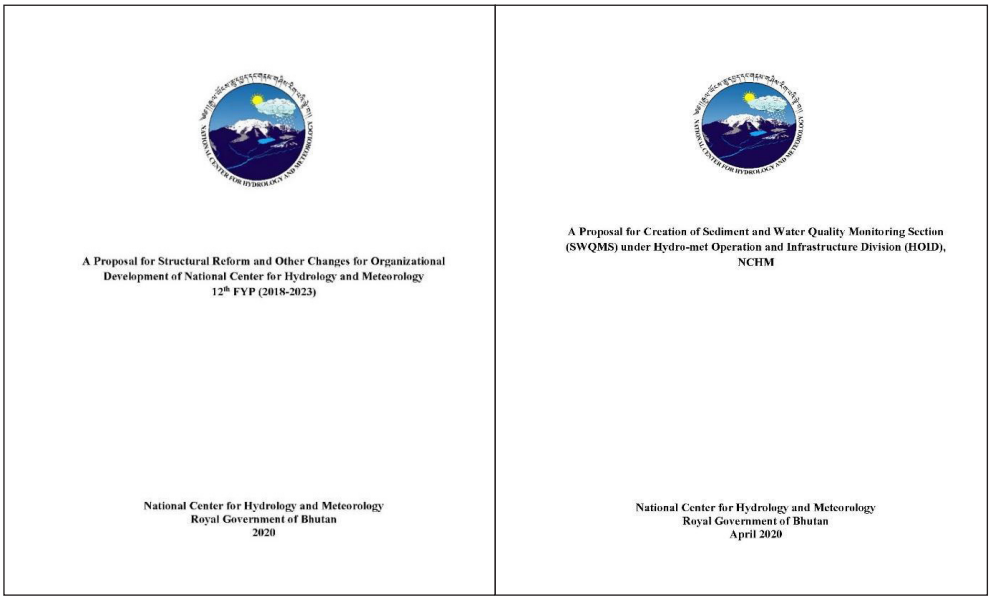
a. To improve the center's capacity to handle its internal and external functioning and relationships;

b. To ensure proper classification of position titles and categories through harmonization of the position titles;
c. To ensure clear career progression for existing officials
d. To align organization structure with strategy and long-term goals.

Similarly, as per the Water Quality Standard (WQS) 2018, NCHM is identified as the Competent Authority (CA) for the monitoring of Ambient Water Quality (AWQ) with following roles and responsibilities:

a. Conduct ambient water quality monitoring (WQM) of rivers and streams along with other hydrological observations in all the hydrological stations operated by NCHM.
b. Install additional water quality monitoring stations/sites in consultation with the NECS.
c. Provide technical support to the NECS/other agencies in WQM monitoring and related works.
d. Collect, process and maintain a water quality database for record/archival.
e. Prepare and submit to the NECS, an annual Water Quality Report covering status and trends in water quality of rivers and streams.

A proposal to create Sediment and Water Quality Monitoring Section (SWQS) under the Hydro-met Operation and Infrastructure Division (HOID) by expanding the existing Sediment lab to carry out the above additional responsibilities was submitted to RCSC in 14 April 2020



A Proposal for Structural Reform and Other Changes for Organizational Development of National Center for Hydrology and Meteorology
12th FYP (2018-2023)

National Center for Hydrology and Meteorology
Royal Government of Bhutan
2020

A Proposal for Creation of Sediment and Water Quality Monitoring Section (SWQMS) under Hydro-met Operation and Infrastructure Division (HOID), NCHM

National Center for Hydrology and Meteorology
Royal Government of Bhutan
April 2020

22. Governing Board Meeting

20.1 The 4th Governing Board Meeting of the Center was held on 3rd January 2020 at Osel Hotel, Thimphu. The meeting was chaired by Dasho Sonam P. Wangdi, Chairman of GB/Secretary, National Environment Commission (NEC) and was attended by GB members. The meeting endorsed the:

a. Guidelines on the Exchange and Dissemination of Hydrological and Meteorological Data and Information,
b. Hydromet Policy of Bhutan Concept Note for submission to GNHC.

Figure 36: Board Members with the Chairman, Dasho Sonam P Wangdi during 4th GB meeting on 3 January 2020

20.2 The 5th Governing Board Meeting of the Center held 12 June 2020 at Norkhil Boutique Hotel & Spa, Thimphu.

Figure 37: Board Members with the Chairman, Dasho Sonam P Wangdi during 5th GB meeting on 12 June 2020.

23. Bilateral Meeting

23.1. Joint Group of Experts (JGE) on Flood Management between Bhutan and India

The Joint Group of Experts (JGE) on Flood Management between Royal Government of Bhutan (RGoB) and Government of India (GoI) was established in 2004 with constituted with following Terms of Reference (TOR):

"To discuss and assess the probable cause and effects of the recurring floods and erosion in the southern foothills of Bhutan and adjoining plains in India and recommend to both Government, appropriate and mutually acceptable remedial measures".

The 9th Meeting of the Joint Group of Experts (JGE) on Flood Management between Bhutan and India held on 7-8 January 2019 at Punakha, Bhutan. The meeting reviewed the 6th Joint Technical Team (JTT) meeting report. JGE members visted PHPA-I, GLOF EWS Control room, Wangdue.

Figure 38: Member of the 9th Joint Group of Expert (JGE) Meeting.

23.2. Meeting of the Joint Technical Team (JTT) between India and Bhutan

The 6th meeting of the Joint Technical Team (JTT) of Flood Management between the Royal Government of Bhutan and Government of India was on 12-13 September 2019 in Jalpaiguri, Assam. Dr. Singay Dorji, Chief, Weather and Climate Services Division, NCHM lead the Bhutanese delegation for the meeting. JTT visited the flood affected areas on Indian sides.

Figure 39: JTT Team members during JTT meeting in Jalpaiguri, Assam.

24. Regional and international meeting

24.1. Familiarization Visit to WMO, Geneva, Switzerland, 25-27 September 2019

On the invitation of the Secretary General, World Meteorological Organization (WMO), the Director as the Permanent Representative (PR) of Bhutan with WMO attended the familiarization visit to WMO Secretariat Geneva, Switzerland, 25-27 September 2019 and then to Korean Meteorological Administration (KMA), Seoul, Republic Korea, 30 September to 1 October 2019.

During his stay in Geneva, the Director made a courtesy call to the Secretary General, WMO and had a bilateral discussion on the project/programme with WMO Department Directors and project managers. During his visit to KMA the Director met with Mr. Kim Jongseok, the Administrator and Vice Administrator of Korean Meteorological Administration and visited the Information Communication Center (ICC), National Weather Center (NWC), National Center for Meteorological Supercomputer and National Meteorological Satellite Center.

The familiarization visit for new PRs was organized by WMO for “Better understanding the activities of WMO and to various correspondence thereafter” and other NMHS.

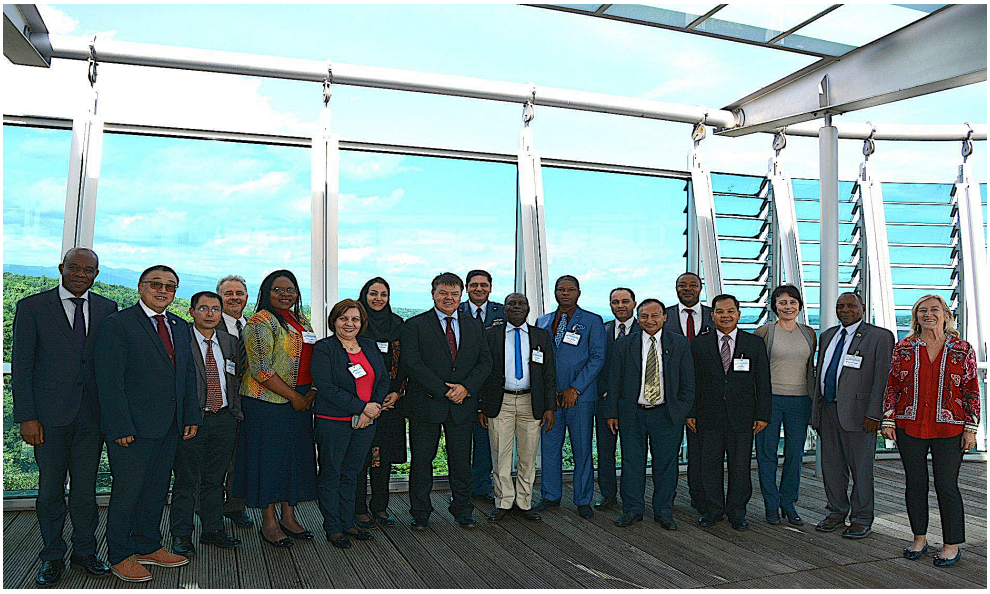


Figure 40: Secretary General, WMO with Permanent Representatives

Figure 41: Mr. Kim Jongseok, the Administrator of KMA with PR of Bhutan, Thailand and Nepal.

24.2. RIMES 11th Annual Program Meeting, Bangkok, Thailand from 20-22 January, 2020

Regional Integrated Multi-Hazard Early Warning System (RIMES) for Indian Ocean is an intergovernmental, non-profit organization registered with the United Nations, under Article 102 of the United Nations Charter mandated to provide regional early warning services within the framework of IOC/UNESCO and WMO to build capacity of its members' countries in the early warning of tsunami and other hydro-meteorological hazards and risks. Currently there are 22 members and 19 collaborating countries working with RIMES

Based on the invitation letter of RIMES, Director of NCHM attended the RIMES 11th Annual Program Meeting held in Bangkok, Thailand from 20-22 January, 2020.

24.3. Intergovernmental Panel for Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. The IPCC provides regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. IPCC was created by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC is an organization of governments that are members of the United Nations or WMO. Each IPCC member government has a National Focal Point identified by the relevant authorities of the Country. IPCC National Focal Points prepare and update the list of national experts to help implement the IPCC work program.

The National Center for Hydrology and Meteorology (NCHM) is designated National Focal of Bhutan with IPCC attending the following meeting during the FY 2019-2020 with funding from the IPCC Trust.

Sl. No	IPCC Meeting	Date	Venue	Financial Year
1	Mr. Phuntsho Namgyel, Chief of Hydro-met Operation and Infrastructure Division attended the Fifty-first Session of the IPCC(IPCC-51) and Second Joint Session of the IPCC Working Groups I & II.	20-23 August 2019	Monaco	2019-2020
2	Phunstho Tshering, Oftg Chief, CSD attended the Fifty-Second Session of the Intergovernmental Panel on Climate Change (IPCC-5	February 24 – 29, 2020	UNESCO HQ, Paris, France	2019-2020

25. Important events

25.1. Science Seminar on Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOF) from 26-27 November 2019.

NCHM in collaboration with the Department of Local Governance (DLG), Ministry of Home and Cultural Affairs with fund support from UNDP organised a Science Seminar on Climate Change-induced Risks and Vulnerabilities of Glacial Lake Outburst Floods (GLOF) from 26-27 November 2019 at Punatsangchhu Cottages, Wangdue Phodrang.

The Honourable Chairperson Lyonpo Tashi Dorji, National Council of Bhutan graced the opening session as the Chief guest along with officials from UNDP, NCHM, DLG, MoHCA. The seminar was attended by the Dasho Dzongda of Gasa, Wangdi and officials and elected local governments of Gasa, Punakha and Wangdiphodrang. More than 70 participants including local government officials, civil servants, project officials, defense, law enforcement, media, policy makers attended the seminar. NCHM shared the status of glaciers and its associated risks and GLOF EWS installed with participants. The participants also visited the GLOF EWS Control Room.

Figure 42: Honorable Chairperson of National Council with participants.

25.2. New JICA TCP Project Record of Discussion signed

The Record of Discussions (RD)on the upcoming JICA TCP Project on "Capacity Enhancement of Meteorological Observation, Forecasting and Flood Warning for Disaster Preparedness and Response in Thimphu and Paro River Basins" was signed on 31st October 2019. The Technical Cooperation Project (TCP) support NCHM, DDM and other counterpart agencies to:

a. Enhance capacity on flood hazard assessment, forecasting and early warning in target river basins (Pachhu and Thimchu);
b. Enhance capacity on weather observation, forecasting and communication of weather information; and
c. Enhance capacity for flood disaster preparedness and response in the target Dzongkhag of Thimhpu and Paro river basin.

The three years Project was expected to be implemented from February, 2020 but got delayed due to COVID19 pandemic.

After the signing Mr. Kozo Watanabe, Chief Representative of JICA Bhutan Office, and officials from GNHC visited the National Weather and Flood Warning Center (NWFWC), NCHM.

Figure 43: Chief of JICA Bhutan Office Mr. Kozo Watanabe and GNHC officials visited NWFWC, Thimphu

25.3. Debriefing for a Special Duty Team at Lunana, GASA

The Center is responsible for operation of Flood Warning Office established at Thanza, Lunana, Gasa after the 1994 GLOF. The Site Office is equipped with HF Wireless and mobile communication. The Flood Warning Office at Thanza, under Gasa Dzongkhag communicates directly with GLOF EWS Control Room, Wangdi, which is operational 24/7. Every year the Center deputes a team of two staff on a special duty to Lunana for a period of one year.

Mr. Leki Chojay and Mr. Jigme Lhuendup, Hydro-met Technician volunteered to go on Special Duty at Lunana, Gasa for the FY 2019-2020. They are primarily responsible for physically monitoring glacier lakes of Lunana as a back to automatic GLOF EWS. They transmit the data and information to Wangdue Control Room on a sub-daily basis via HF Wireless or mobile. The management briefed the team on 10 September 2020 before their departure to Lunana.

Figure 44: NCHM Management with Mr. Leki Chogay and Mr. Jigme Lhuendup (Before departure to Lunana) and Mr. Tsheirng Wanghcuk and Mr. Sonam Dorji, (who returned from Lunana)

25.4. Civil Servant Marathon

The officials from the Center participated in the Civil Servant Marathon organized by RCSC on on 10 August 2019.

Figure 45: The Center Officials participated in the Civil Servant Marathon.

25.5. AM with PM Program

AM with PM program of the Center with the Honourable Prime Minister of Bhutan was held 9th August 2019. Prior to the meeting, the Honorable Prime Minister Dr. Lotay Tshering visited the 24/7 operational National Weather and Flood Warning Center (NWFWC) in Thimphu. NWFWC is the main supervisory and command center of NCHM for monitoring and dissemination of weather, climate and flood warnings to the Department of Disaster Management (DDM), line agencies, local government and public. During the meeting NCHM raised the following issues for directives.

a. Land for construction of NCHM HQ, and Scientific facilities as planned in 12 FYP
b. Increase the payment of part-time Observers and
c. Night shift allowance for 24/7 operation of NWFWC and GLOF EWS Control room Operators

Figure 46: NCHM AM with PM Program with the Honourable Prime Minister of Bhutan.

25.6. Thorthormi Lake GLOF 21 June, 2020

Subsidiary lake II of Thorthomri lake was breached on 21 June 2020 at around 19:00 hours in the evening causing GLOF. NCHM alerted the relevant Central agencies and local governments as per the SOP of the GLOF EWS.

As per the government directive the NCHM a technical team was deputed for rapid assessment of lakes using the Helicopter services from 23-27 June 2020 to Lunana, Gasa to assess the status of the lakes after the 20 June 2019 GLOF. The Rapid Assessment Report and action taken at the sites were presented to the Department of Disaster Management (DDM), MoHCA on 2 July 2019 with recommendations. Team also restored remote water level monitoring stations of GLOF EWS that was damaged by the flood.

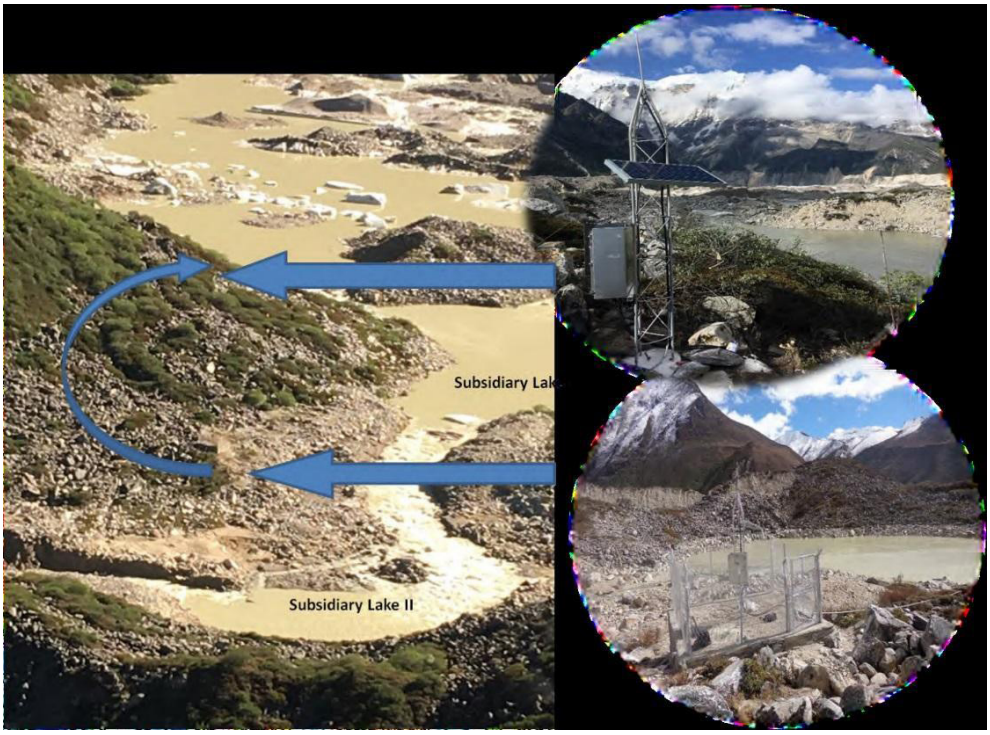


Figure 47: Relocation of damaged AWLS of Thorthormi lake to new site

25.7. Blood Donation Camps

The NCHM officials joined in the voluntary blood donation program organised by the Royal Civil Service Commission in collaboration with the Ministry of Health on 13 April 2020 at Yangchenphug Higher Secondary School for preparedness against the COVID-19.

Figure 48: NCHM's Officials donating the blood.

25.8. Presentation to the Environment and Climate Change Committee of the National Assembly of Bhutan on SDG: Goal 13 (Climate Action).

As per the directive of the Environment and Climate Change Committee of the National Assembly of Bhutan, the Center made the presentation on the Center role in fulfilling the Sustainable Development Goal 13 to the Environment and Climate Change Committee of the National Assembly of Bhutan on 30 December 2019.

The Committee members were briefed on the Center mandates, plans and activities that are directly linked with objectives of Climate Action. The Center also updated the committee on activities that are carried out to combat climate change including the updated Assessment of Potentially Dangerous Glacial lakes and annual monitoring and measurement of Glacier Mass Balance.

Figure 49: NCHM Presentation to Environment and Climate Change Committee Members of National Assembly

25.9. De-suung Integrated Training Programme

A total of four staff from the Center attend the Accelerated De-suung Integrated Training Programme organised by the Desuung Office. The Center formally welcomed the officials upon successful completion of the training program.

Figure 50: NCHM Management with 39th and 40th De-suung Batches.

25.10. Orientation Programme for New Recruits

The Center conducted two days orientation programme for newly recruits and lateral transferred officials with objectives to induct the candidates into the Civil Service at large and in particular integrate and assimilate the candidates as a team player in the organization from 17-18 February 2020.

The officials were briefed to familiarize with organization plans and objectives including physical, work culture and organizations values. Inddition, they are made aware of the organization policies, plans & programmes, BCSR, Financial Rules and their job description with the expectations of the Agency.

Figure 51: Director and Chiefs with New Staff of the Center.

25.11. New Chief, Hydrology and Water Resources Services Division

Mr. Tayba Buddha Tamang joined as the new Chief of Hydrology and Water Resources Services Division on 15 May 2019. Prior to joining he was working as the Dy. Chief, Climate Information Section under the Weather and Climate Services Division (WCSD) of the Center.

Figure 52: Director and Chiefs with New Chief during the joining ceremony.

25.12. Observing Zero Waste Hour

In pursuant to the launch of the Zero Waste Hour on 2 June 2019 by Her Majesty the *Gyaltsuen* coinciding with the Coronation Day of His Majesty the Fourth Druk Gyalpo, every second day of every month is observed as the Zero Waste Hour. The Center HQ and all the site's offices made it mandatory to observe the Zero Waster Hour every 2nd of the month by cleaning the office surroundings and Hydro-met Station site throughout Bhutan.

Figure 53: NCHM Staff observing Zero Waste Hour.

25.13. Civil Service Award Ceremony 2019

The Civil Service Award Ceremony of the Center was held on December 13, 2019 at the Energy conference hall.

The Director NCHM presented the Royal Civil Service Award medals to the officials of the NCHM in a simple ceremony. In total 16 staff of the Center received the medals for 10, 20 and 30 years completion in services and in recognition of their timeless and dedicated services to the nation details are given below.

Table 11.1 : Numbers of employees' recipients for the Royal Civil Service Award

Sl No.	10 years (Bronze)	20 Years (Silver)	30 Years (Gold)	Lifetime
1	7	5	3	1

NCHM also awarded certificates of appreciation to the four Outstanding Employees of the year 2018-2019. Tashi Khadar with office order were issued to16 employees whose broadband promotion was due in July 2019 during the ceremony.

Sl.No.	Broad-banded promotion
1	16

Figure 54: NCHM Civil Servant Award

26. Human Resources Development

26.1. Refresher Course on Weather Forecasting from 22-23 January 2020 at National Weather and Flood Warning Center (NWFWC), NCHM.

The Weather and Climate Services Division (WCSD) conducted the two days refresher course on Weather Forecasting for weather forecasters in Thimphu from 22-23 January 2020 to enhance the capacity forecasters on the Standard Operating Procedures (SOP) for Weather Forecasting and Dissemination of Forecasts Products and Services Version 1.0. The course also included hands-on training on troubleshooting of the systems at the NWFWC and use of South Asia Flash Flood Guidance system (SAsiaFFGS).

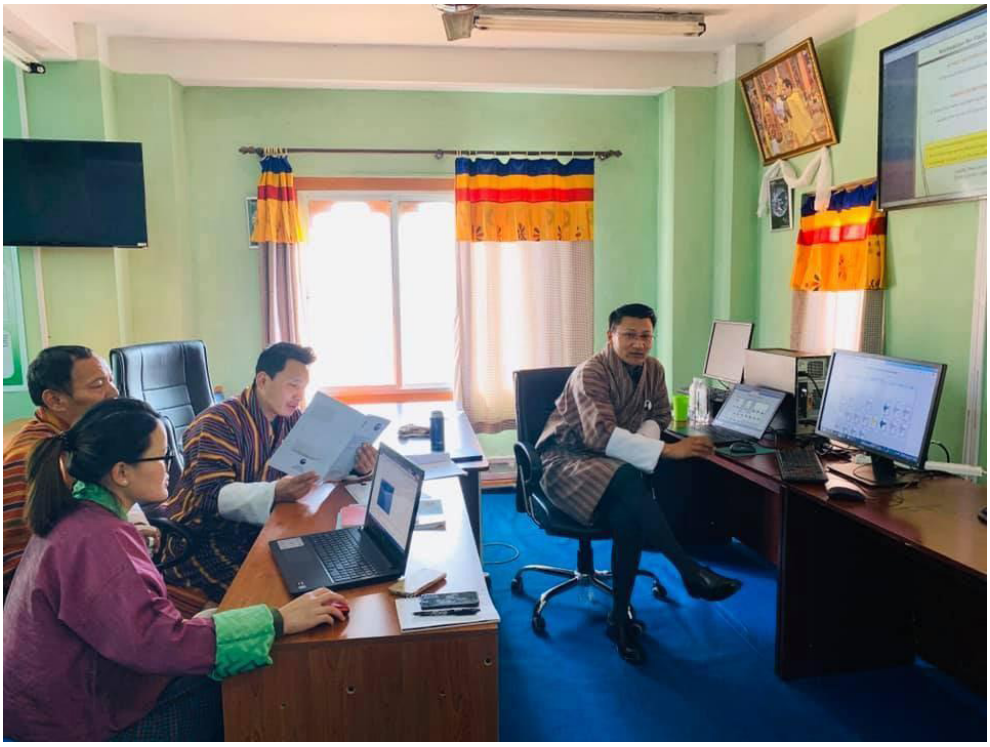


Figure 55: Refresher Course training to Weather Forecaster Officials of the Center.

26.2. Effective Writing Skills Workshop for NCHM Officials

A 3-day Workshop on Effective Writing Skills for NCHM Staff was organised in Thimphu 29-31 October 2019 with an objective to enhance communication skills in effective writing. The workshop was supported through the World Bank supported project “Strategic Planning for Climate Resilience (SPCR) component. Effective writing skills are very important for the staff working in the Center to be equipped

with good communication skills, especially in writing scientific findings and quality reports that are crisp, concise, informative and understandable to the non-scientific communities. More than 20 staff of the center attended the workshop. The training was conducted by Mr. Gopilal Acharya, a consultant/Journalist and communication expert of M/s Mad Monk Consulting based in Thimph. Mr. Gopilal Acharya was hired as he has previously worked with the International Center for Integrated Mountain Development (ICIMOD), Kathmandu as a communication specialist.

Figure 56: Director of NCHM with facilitator and trainees

26.3. Climate Data Management System Training

NCHM organized the Climate Data Management System (CMDS) training in Thimphu from 15-16 July 2019 with resource person (Mr. Samuel Machua, Consultant) deputed by World Meteorological Organization (WMO) under the Voluntary Contributions Programme (VCP) of the WMO funded by the UK Met Office. CDMS is an integrated computer-based system that facilitates the effective archival, management, analysis, delivery and utilization of a wide range of integrated climate data. CDMSs offer improved data access and security and much greater utility for users. CLIMSOFT is one of the CDMS software suites for storing climate data in a secure and flexible manner and for extracting useful information from the data like summary reports, maps or diagrams.

Figure 57: Mr. Samuel Machua with the Data Managers of the Center

26.4. Ex-country Trainings (STT)

Through the support of international, bilateral and projects funding programs, more than 15 employees of the Center attended various trainings outside in various countries for the FY 2019-2020. Detail as given below.

Table 12: Summary of Ex-Country Training

Sl.No.	Number of Training	Number of Officials attended
1	8	15

26.4.1. Aviation Weather Risk Management Course

Two staff from Aviation Meteorological Section, Paro International Airport attend the Weather Risk Management Training at Singapore Aviation Academy (SAA), Singapore with the funding support from Singapore – ICAO Programme for Young Aviation Professionals (PYAP) from 22-26 July 2019. The course was designed to equip participants with the knowledge and skills to determine how hazards and risks from adverse weather conditions impact flight operations, and ways to manage the risks.

Figure 58: Participants of Aviation Weather Risk Management Course.

26.4.2. Safety Oversight of Aviation Meteorological Services

Mr. Sonam Rapten, Head of Aviation Meteorological Section, Paro International Airport, attended the Safety Oversight of Aviation Meteorological Services at Singapore Aviation Academy (SAA), Singapore with funding support from the Singapore-ICAO Developing Countries Training Programme.

Figure 59: Participants of Safety Oversight of Aviation Meteorological Services Course.

26.4.3. Ex-Country Meetings/Workshop/Conference

As per the mandates of NCHM, during the FY 2019-2020 officials attended mandates of bilateral, regional and international meetings conferences and symposiums related to weather, climate, cryosphere and water resources.

Table 14: Summary of Ex-Country Meetings/Workshops/Conference

Sl.No.	Number of Meeting/Workshop	Number of Officials attended
1	32	34

26.5. Long Term Study

Currently, the following officials are pursuing long-term studies.

Table 15: List of employees pursuing long-term studies

Sl No.	Name/Designation	Course	Institute/Country	Funding
1	Mr. Ugyen Chophel	Master of Statistics	Australia National University, Canbara	Australia Awards Scholarship (AAS)
2	Ms. Sonam Pelden	Human Resource Management	Australia	Self Funding
3	Mr. Jai Ram Rai	Bachelors of Engineering in Power Engineering	JNEC, Bhutan	Self Funding
4	Mr. Bikash Pradhan	Environmental system	Humboldt /State University, Arcata, California, United State of America	UNDP-GEF(RCSC)

27. Wellbeing of staff

27.1. Annual General Meeting of NCHM Staff Welfare Scheme

The National Center for Hydrology and Meteorology Staff Welfare Scheme (NCHMSWS) was established in July 2017 with the objectives to render financial, physical and moral support for the wellbeing of the staff during the difficult times. The Second Annual General Meeting of NCHMSWS was held on 15 July 2019 at the Energy Conference Hall, MoEA.

Figure 60: NCHMSWC Annual General Meeting

27.2. Farewell to Mr. Phuntsho Namgyel,

Mr. Phuntsho Namgyel, Chief of Hydro-met Operation and Infrastructure Division, NCHM was selected as a new Director of Department of Renewable Energy, Ministry of Economic Affairs (MoEA) through open competition. The NCHM family organised a farewell tea as a token of appreciation and wishing him best of luck in his new career.

Figure 61: Director, NCHM with New Director of Department of Renewable Energy (DRE), MoEA.

27.3. NCHM Headquarter Potluck Lunch

To promote solidarity and interaction among the staff, the Center has initiated Potluck lunch every last Friday of the month, however, it has to be temporarily discontinued after COVID19 pandemic from March 2020.

Figure 62: NCHM monthly potluck program.

28. Challenges and Issues

Being the new autonomous agency entrusted with technical and scientific mandates, the Center is facing a number of challenges from financial, human resources, office space to technical and scientific facilities. The following are three key issues and challenges that need immediate interventions.

a. Lack of Office Space and Scientific Facilities
b. No Hydromet Policy and related Legislation
c. Nature of job and 24/7 functions and
d. Limited trained technical professional for effective delivery of hydro-met services