



ANNUAL REPORT

2021-2022

NATIONAL CENTER FOR HYDROLOGY AND METEOROLOGY
ROYAL GOVERNMENT OF BHUTAN
THIMPHU: BHUTAN
July 2022



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National Centre for Hydrology and Meteorology
Royal Government of Bhutan
Thimphu: Bhutan
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during the 114th National Day at Tashichhodzong
(Sources: *Kuensel*, December 18, 2021 Issue)

Acronyms:

12 FYP	Twelfth Five Year Plan
AWLS	Automatic Water Level Station
AWS	Automatic Weather Station
BFL	Bhutan for Life
CDBMS	Centralized Database Management System
CSD	Cryosphere Services Division
DDM	Department of Disaster Management
DGPC	Druk Green Power Corporation
DIT	Department of Information Technology
EWS	Early Warning System
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
GLOF	Glacier Lake Outburst Flood
GoI	Government of India
GTS	Global Telecommunication
HOID	Hydro-met Operation and Infrastructure Division
HQ	Headquarter
HWRSD	Hydrology and Water Resources Services Division
ICT	Information Communication Technology
IFAS	Integrated Flood Analysis System
JICA	Japan International Cooperation Agency
LDCF	Least Developed Country Funding
MHPA	Mangdechhu Hydropower Project Authority
MoHCA	Ministry of Home and Cultural Affairs
NAP	National Adaptation Plan
NCHM	National Center for Hydrology and Meteorology
NEC	National Environment Commission
NFCS	National Framework for Climate Services
NFWWC	National Weather Flood and Warning Centre
OEM	Original Equipment Manufacturer
PHPA	Punatsangchhu Hydropower Project Authority
R&D	Research and Development
RCSC	Royal Civil Service Commission
RGoB	Royal Government of Bhutan
RIMES	Regional Integrated Multi-Hazard Early Warning System
SOP	Standard Operating Procedure
TSDR	Technical Standard Research Division
UNDP	United Nation Development Programmed
WB	World Bank
WCSD	Weather and Climate Services Division
WIS	Weather Information System
WMO	World Meteorological Organization
WRF	Weather Research and Forecast.

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Figure 1: Automatic Water Level Station (AWLS), Rapstreng Tsho, Lunana for GLOF EWS

1 ORGANIZATION

The National Centre for Hydrology and Meteorology (NCHM) is a scientific and technical autonomous agency of the Royal Government of Bhutan created in 2016. The Centre is responsible for understanding the behaviors of the atmosphere, its interaction with cryosphere and water bodies, the weather and climate and distribution of the country's water resources. It is the nodal agency responsible for the generation of information and delivery of products and services on weather, climate, cryosphere and water resources in Bhutan.

The Centre was created to improve the efficiency and effectiveness in providing information and services of hydrology, meteorology, cryosphere and climate sciences that are required by various sectors and the public.

2 GOVERNING BOARD

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

- a. Secretary, National Environment Commission Secretariat (NECS) - Chair
- 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

Vision

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

3.2 MISSION

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.

3.3 CORE VALUES

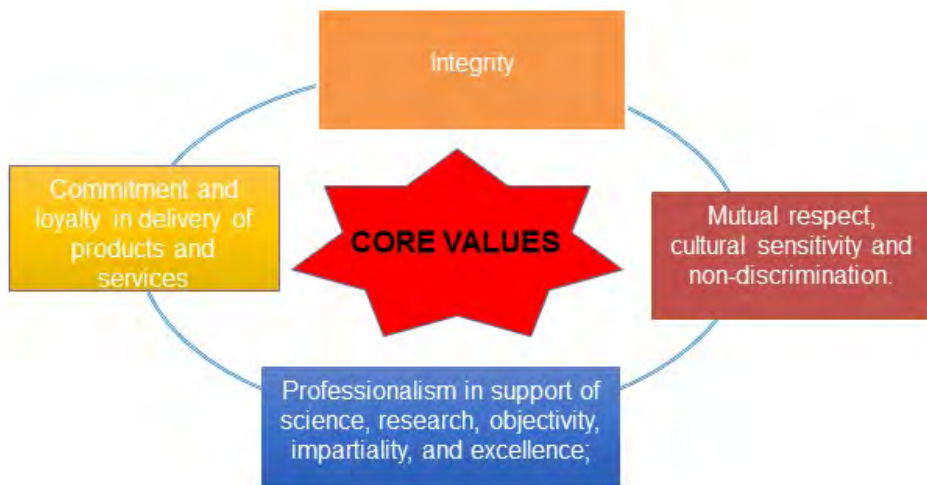


Figure 2: NCHM Core values

3.4 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 fulfil 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 and agro-meteorological services, 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. Data collection, 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.

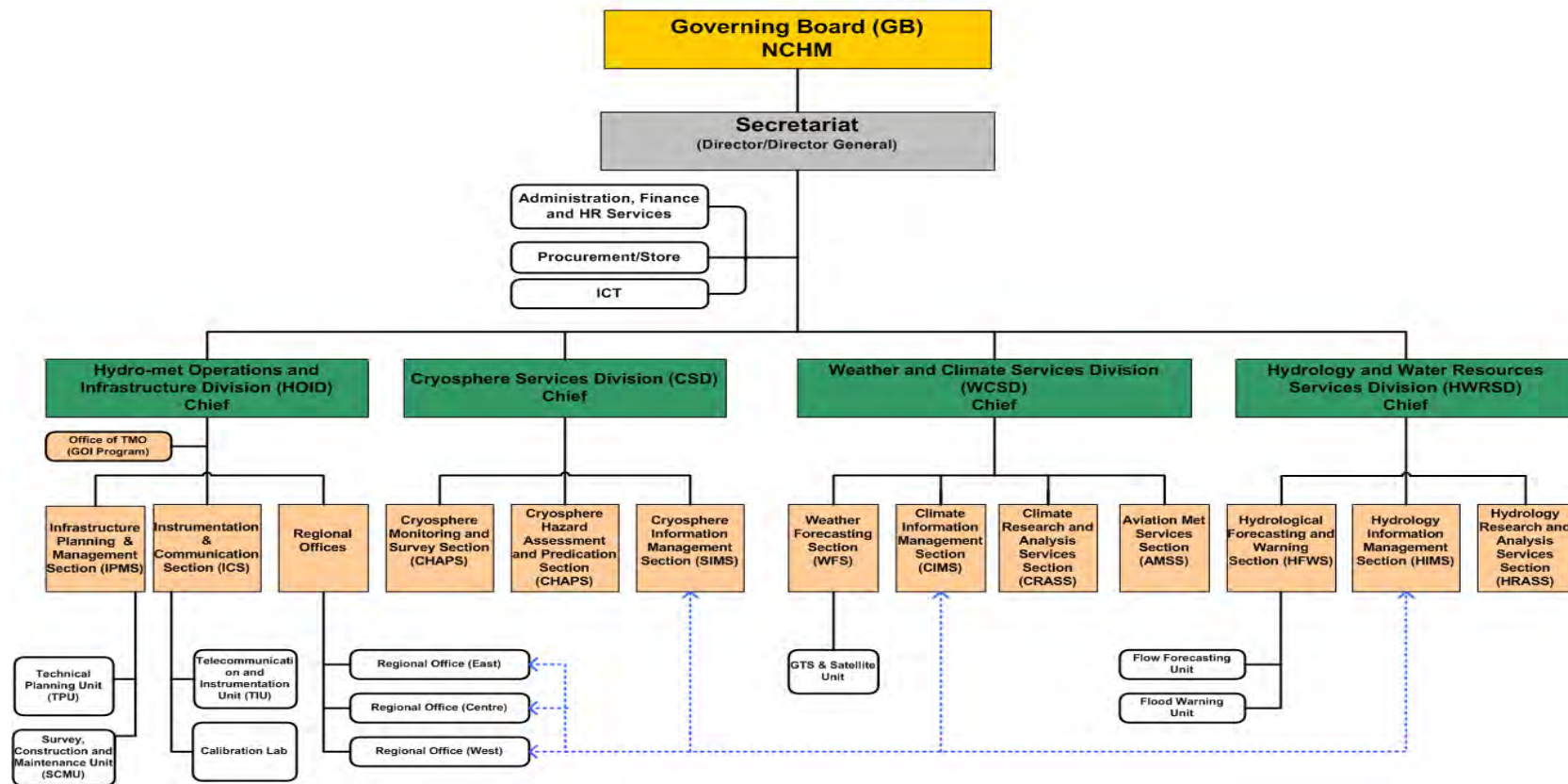


Figure 3: NCHM approved organogram (RCSC, 2016)

5 ORGANIZATION STRUCTURE AND STAFFING

5.1 INTERNAL RE-ORGANIZATION

Internal re-organisation of NCHM was proposed in 2020 based on additional mandates on ambient water quality monitoring from NECS, to streamline functions within the Centre for effective utilization of manpower (resizing- do more with same number) with following objectives:

- a. To improve the center's capacity/competency to handle its internal and external functioning and relationships;
- b. To ensure proper classification of position titles and categories through harmonisation of the position titles;
- c. To ensure clear career progression for existing employees and
- d. To align organisation structure with strategy and long-term goals for effective delivery of services.

The following proposals for structural changes and staffing of the Centre were submitted to RCSC for review and considerations:

- a. Proposal for Structural Changes, Division Creation, Position Title and Change in position directory submitted to RCSC in 6 April 2020
- b. Upgrade Section to Division (Aviation Meteorological Services Division (AMSD))
- c. Creation of Sediment and Water Quality Monitoring Section Submitted to RCSC in 14 April 2020
- d. Dissolve Hydro-met Operation and Infrastructure Division (HOID) and mandate and merge staff with respective Weather and Climate Services Division (WCSD) and HWRSD and
- e. Create a new Technical Standard and Research Division

Accordingly, the RCSC approved the following:

- a. Dissolution of HOID,
- b. Dissolve of Regional Office, East in Mongar,
- c. Approved creation of Technical Standard and Research Division (TSRD)
- d. Entry Level of Meteorology/Hydrology Technician at S3A with certificate course from TTI.

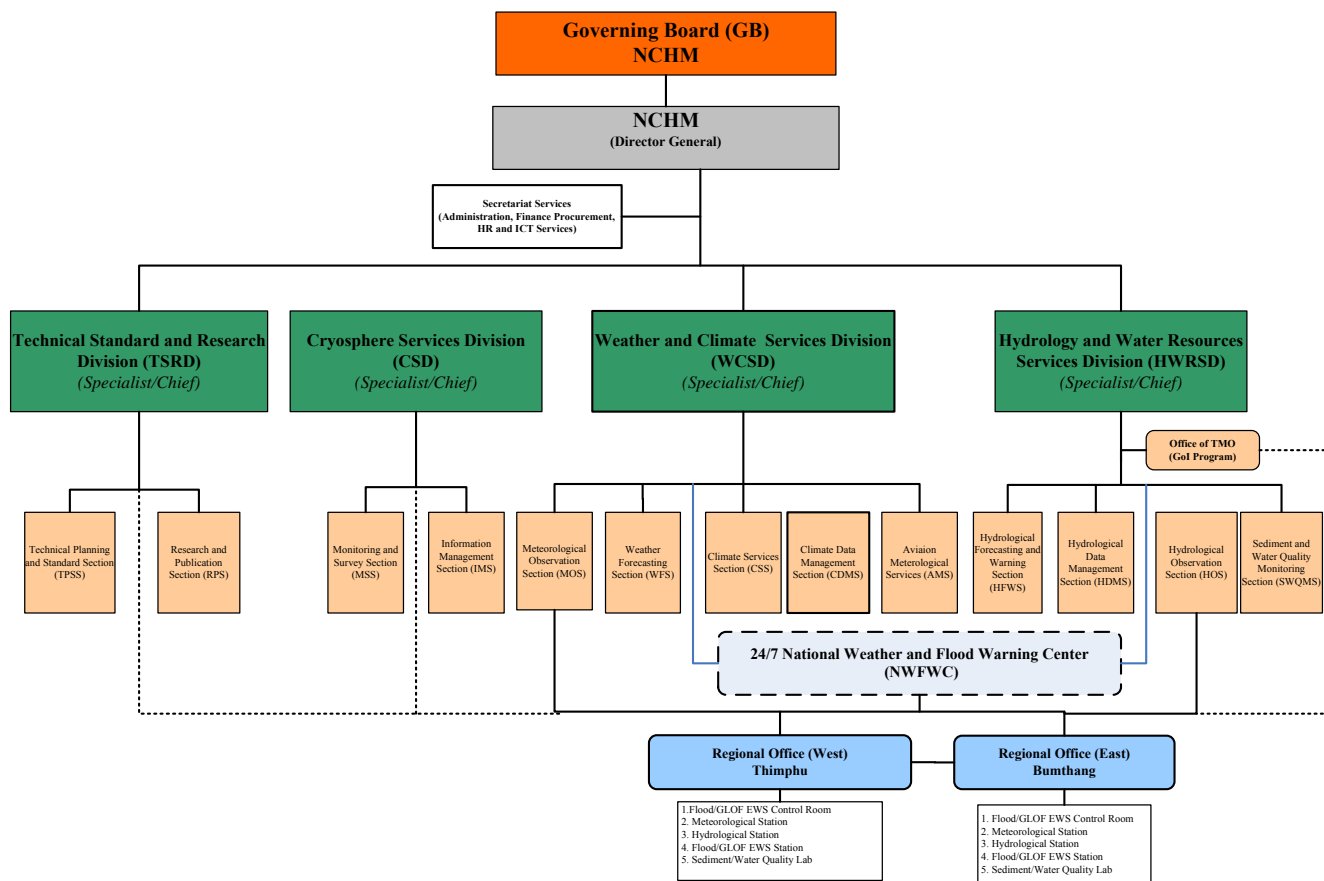


Figure 4: Revised Organogram of NCHM (After Internal re-organisation, 2022)

5.2 STAFFING

Currently there are 197 employees working in the Centre including ESP/GSP under the Flood Warning Services (GoI Program). The detailed staffing strength and distribution is presented in the table 1 below:

Table 1: Staff strength and distribution

Division/Secretariat	Approved	Existing	Gap	Remarks
Secretariat	21	19	2	<i>Including 8 Drivers and 1 ESP</i>
Weather and Climate Services Division	32	32	0	
Hydrology and Water Services Division	16	14	2	
Cryosphere Services Division	8	7	1	
Hydromet Infrastructure and Operation Division	143	125	18	<i>Including 13 ESP/GSP under GoI Program</i>
	220	197	23	

Distribution of employees by position are shown in the graph below. The Centre 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 70%) are under the Support and Supervisory category followed by Professional and Management level (15%).

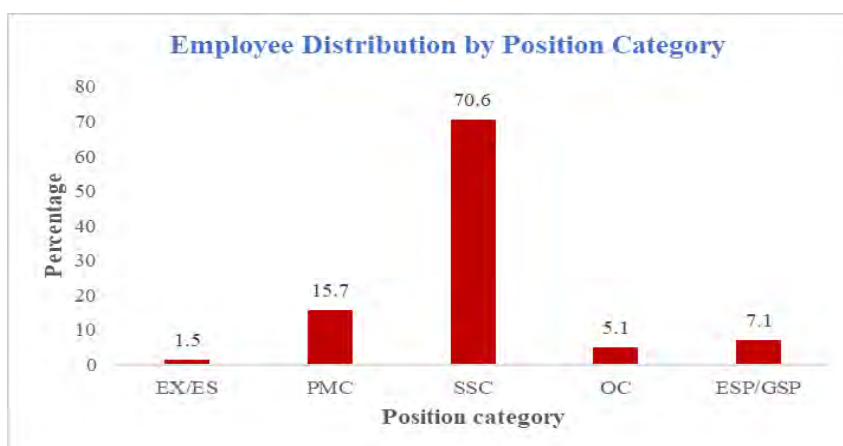


Figure 5: Distribution of Employees by Positions

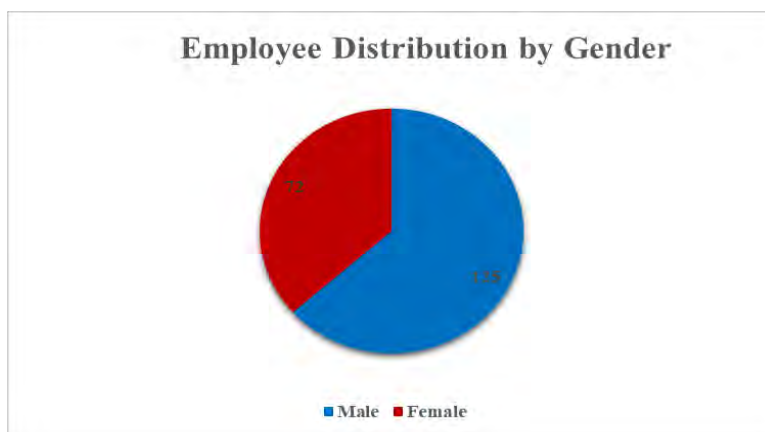


Figure 6: Distribution of Employees by gender

Out 197 regular employees, 125 (64%) are male and 72 (36%) are female. Male domination may be due to the technical nature of Centre's the jobs, however, compared to the past years, the number of females joining the Centre are increasing every year.

5.3 STAFF SUPERANNUATED

Total of three staff superannuated after serving more than three decades of their dedicated services to the nation and others separated on voluntary resignation in the FY 2021-2022.



Figure 7: Employees superannuated in 2021-2022 (Mr. Ambar Gurung (Rt) and Mr. Dawa Tenzin(L)

5.4 NEW STAFF

A total of five employees joined the Centre during this financial year under new appointment and transfers. The details of new staff are given in the table below.

Table 2: List of new employees joined during the FY 2021-2022

Sl#	Name	Employee ID	Position Title	Division	Date of Joining
1	Ms. Phuntsho Wangmo	202107918834	Met/Hyd Officer	HWRSD	06.8.2021
2	Ms. Ugyen Lhamo	202201920621	Met/Hyd Officer	WCSD	14.2.2022
3	Ms. Tshering Lhamo	202201920624	Met/Hyd Officer	WCSD	14.2.2022
4	Mr. Kinley Tshering	9207073	Sr. ICTA	Secretariat	13.4.2022
5	Ms. Yangchen	200805076	Admin. Asst. I	Secretariat	15.2.2022

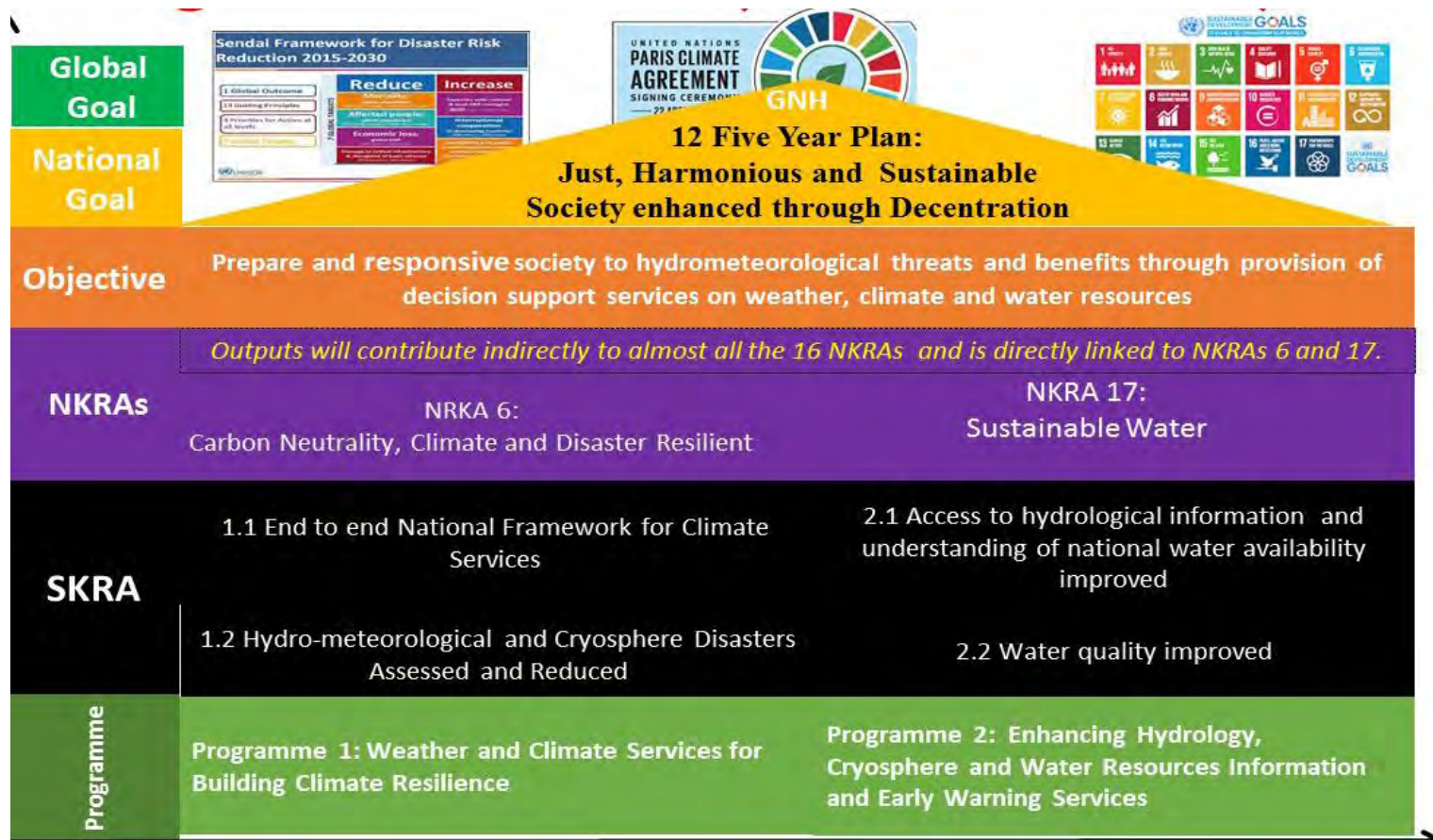


Figure 8: NCHM 12 FYP SKRA linked to NKRA, National and International goals

6 CENTER'S 12 FYP (2018-2023)

The Center's 12th Five Year Plan (2018-2023) has two main programs that are directly linked to NRKA 6 and NKRA 17 (Figure 8) and indirectly programs linked to all the NKRAs and SDG as weather, climate and water resources services are required by all the Sectors.

7 ANNUAL PERFORMANCE TARGET (APT) ACHIEVEMENT

The Annual Performance Plan Target for the FY 2021-2022 was presented to the 8th Governing Board meeting on 28 June 2022.

The Centre APT consists of 9 broad objectives, 11 actions and 11 success indicators. The evaluation was firstly carried out in the Centre by Internal Committee Review (IRC) and later by the National Technical Committee (NTC). The NTC awarded an APT score of 98% for the 2021-2022 (shown in Table 3) in the outstanding category. The FY 2021-2022 success indicators are shown in Table 4.

Table 3: APT Score of the Centre

SI No.	Financial Year	NCHM APT Score
1	2016-2017	97.80%
2	2017-2018	99.45%
3	2018-2019	100%
4	2019-2020	99.75%
5	2020-2021	100%
6	2021-2022	98%

Table 4: Success indicators of NCHM (FY 2021-2022)

SI No.	Action
1.	Assessment of hydrological hazard conducted.
2.	Assessment and monitoring of cryosphere and associated hazards conducted
3.	The critical hydro-met/GLOF infrastructures & network enhanced & maintained
4.	Flood forecast, GLOF/Flood warning/advisories issued.
5.	Weather forecast and advisories on extreme weather events issued
6.	Aviation met services provided
7.	Climate services provided

8.	Mean annual flow of main river basins generated
9.	Monitoring and Transmission of hydro-met data to HQ
10.	Measurement of suspended sediment loads in major rivers
11.	Provided effective and efficient directorate & common services
12.	Integrity score improved
13.	Availability of timely, relevant and reliable data ensured, and decisions improved

The Centre's APT objectives, actions and success indicators for the FY 2021-2022 with achievements are given table 6 attached as the **Annexure -I** of this report.

The Centre has successfully implemented all the mandatory Organization Integrity Action Plan (OIP) for the FY 2021-2022.

8 SUMMARY OF FINANCIAL STATEMENT

8.1 BUDGET APPROPRIATION FOR THE PAST FOUR YEARS

The total budget allocated (RGoB + Donors) to the Centre for the last four years and its expenditure for the FY 2021-2022 is shown in table 5 and table 6 respectively.

Table 3: NCHM Budget summary from 2016-2017 to 2021-2022 (in million)

Sl. #	Funding	2017-2018	2019-2020	2020-2021	2021-2022
1	RGoB	76.87	110.063	115.893	101.191
2	Donors	117.93	64.290	48.533	81.371
	Total	194.80	170.353	164.426	182.562

8.2 FINANCIAL SUMMARY FOR THE FY 2021-2022

Table 4: Expenditure Summary table for the FY 2021-2022

Sl. No.	Funding	2020-2021		Budget Utilization in Percentage
		Approved	Expenditure	
1	RGoB	101.191	98.067	87%
2	Donors ¹	81.371	61.391	
	Total	182.562	159.458	

¹ Donors includes GoI, World Bank, UNDP/GCF, CDCL (DHI), PHPA and others



Figure 9: Class A (Agro-meteorological) Station, Babesa, Thimphu (Top) and CNR Student Observing Soil Temperature (below)

**Highlights of Accomplishments
for the FY 2021-2022**



*Figure 10: Historic snowfall in Punakha, 5th February 2022
(Courtesy: Yellow Bhutan Facebook page)*



*Figure 11: Heavy snowfall in Thimphu, 5th February 2022
(Courtesy: Yellow Bhutan Facebook page)*

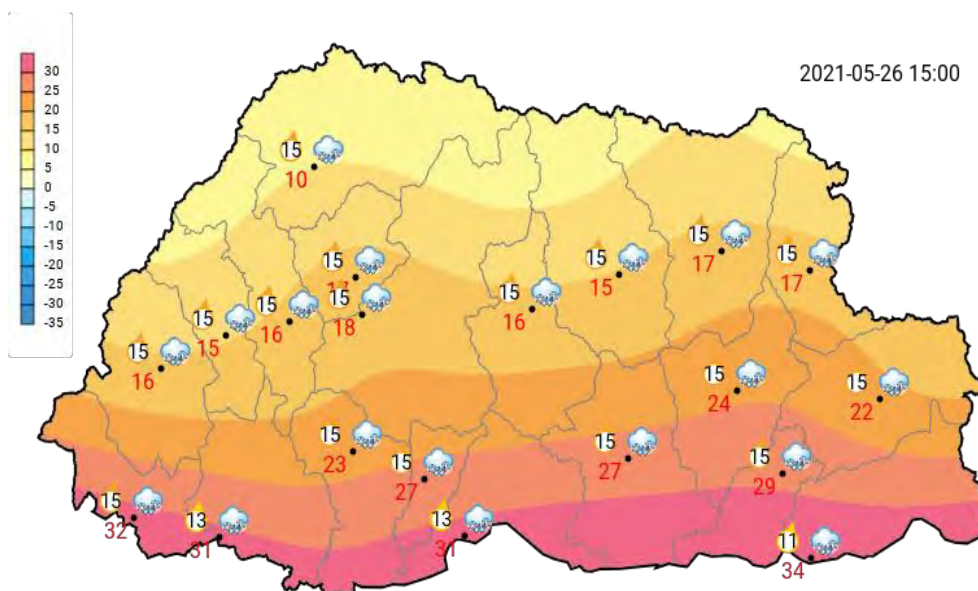
9 NATIONAL FRAMEWORK FOR CLIMATE SERVICES (NFCS)

The Weather and Climate Services Division of the Centre is responsible to study and provide public weather services, severe weather warnings, meteorological data management, aviation meteorology, agro-meteorology and climate change information and services.

9.1 WEATHER FORECAST

The National Weather and Flood Warning Centre (NFWFC), Thimphu operates 24/7 and monitors weather conditions of all the 20 Dzongkhag and issue routine daily weather forecasts through Bhutan Broadcasting Television (TV), radio and social media (Facebook page: <https://www.facebook.com/BhutanWeather>)

Based on severity of weather, the Centre 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. The Center also provides special weather forecasts based on the user's needs and requirements.



9.2 CYCLONIC UPDATES

NWFWC monitor Cyclonic activity and issues warning and advisories to the public.

There was a severe cyclonic storm ASANI over the southeast and adjoining west central Bay of Bengal during the first week of May 2022 but impact to Bhutan.

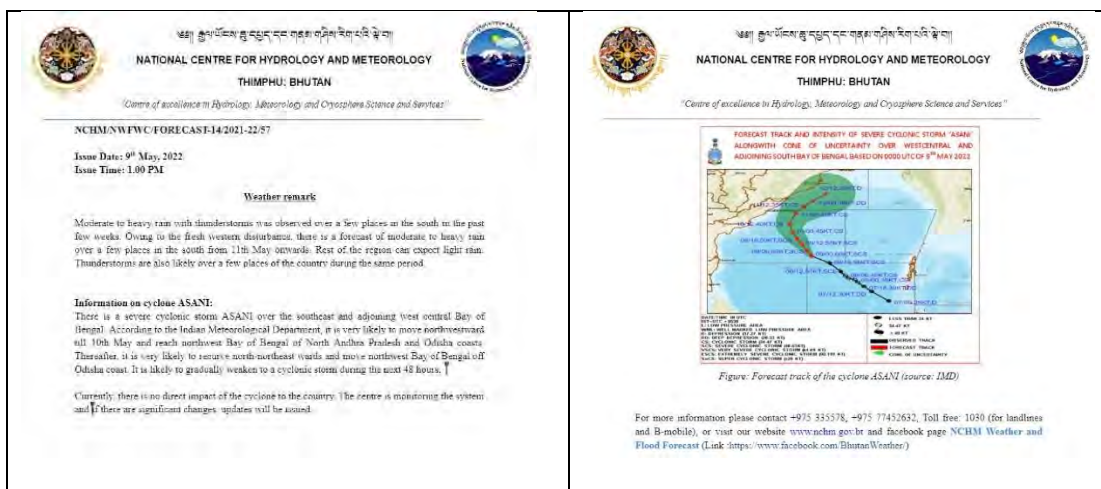


Figure 12: Cyclone ASANI Weather remarks issued on= May 9, 2022.

9.3 AVIATION WEATHER FORECAST

Centre provides aviation forecasts for international and domestic flights including operation of helicopter services.

Issue Date: 22 May 2022	
Issue Time: 12:00 PM	
Weather forecast for Thimphu	
Date	Weather outlook
23 May	Morning: partly cloudy Afternoon: Partly cloudy with light rain Evening/night: Mostly cloudy with light rain
24 May	Morning: Partly cloudy Afternoon: Partly cloudy with light rain Evening/night: Partly cloudy with light rain
24 May	Morning: Partly cloudy Afternoon: Partly cloudy Evening/night: Partly cloudy with light rain
National Center for Hydrology and Meteorology Thimphu	

Figure 13: Aviation weather forecast for Thimphu

9.4 CITY WEATHER FORECAST

As a member of the World Meteorological Organization (WMO), NCHM share and upload weather forecasts for eight identified dzongkhags into the WMO Weather Information System (WIS). It can be accessed from <https://worldweather.wmo.int/en/city.html?cityId=2956>

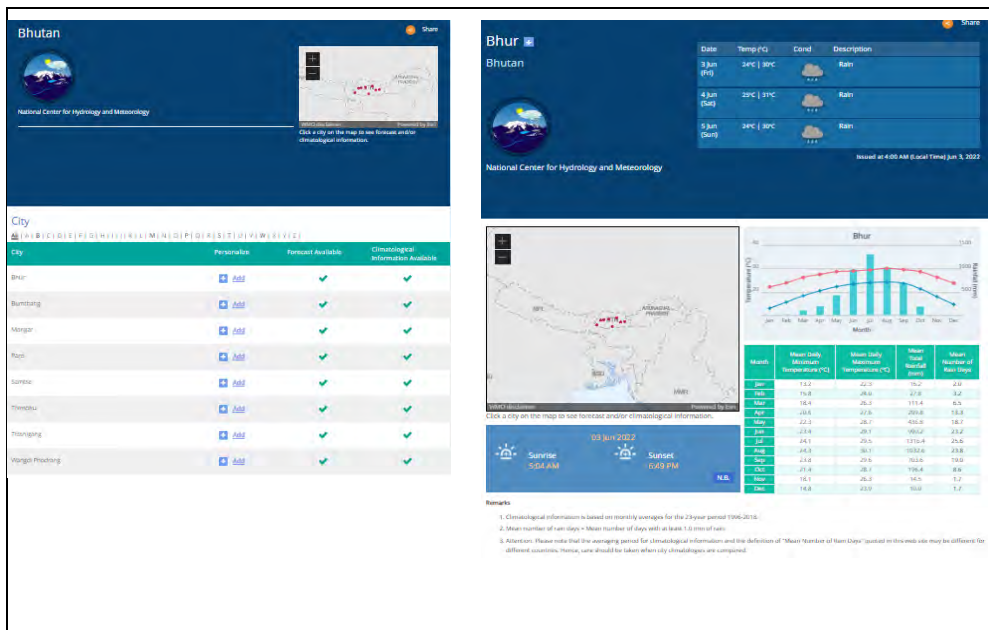


Figure 14: WMO City Weather Forecast of Bhutan (Bhur, Sarpang)

9.5 GLOBAL TELECOMMUNICATIONS SYSTEM

National Weather and Flood Warning Center (NFWFC) operates the Global Telecommunication System (GTS) of WMO within the framework of the World Weather Watch. The GTS is designated as an integrated network for the collection, exchange and distribution of meteorological information by member States. Bhutan as a member of WMO share weather data from Automatic Weather Station (AWS) Tsampa, Bumthang on GTS twice a day at 6:00 AM and 6:00 PM BST.

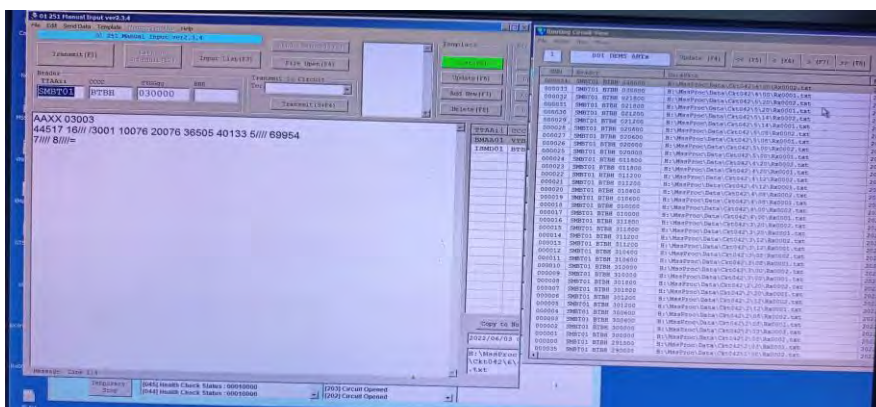


Figure 15: WMO GTS System

9.6 CLIMATE DATA AND INFORMATION SERVICES

The Center provides climate data and services including climate data processing, quality control, analysis and archival. The data is provided to user sectors and individuals as per their request. The Center produced monthly and annual climate monitoring reports, and seasonal forecasts. All the reports are updated on NCHM website. <https://www.nchm.gov.bt/home/pageMenu/777>

9.7 NATIONAL CLIMATE OUTLOOK FORUM (NCOF-8)

The Eight National Climate Outlook Forum (NCOF-8) was held on 27 May, 2022 at Punakha. This forum is a platform 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 the monsoon is issued.

The Center released the outlook of Summer Monsoon 2022 (June-September). The final outlook of summer monsoon of Bhutan for JJAS 2022 based on the forecast of climate predictability tool, considering the consensus outlook of SASCOF-22 and outlook from various other sources. Pangrizampa School of Astrology, *Zhung Dratsang* also shared the 2022 monsoon outlook based on the astrology in the forum.

a. Rainfall Forecast for 2022 Summer Season

The summer rainfall for Bhutan during the 2022 June - September (JJAS) monsoon season is most likely to be slightly above normal. Normal is the average rainfall for the summer season (JJAS) of Bhutan from 1996 to 2021.

b. Temperature Forecast for 2022 Summer Season

The maximum and minimum temperature in Bhutan during the 2022 JJAS monsoon season is likely to be slightly above normal. Normal is the average temperature (maximum and minimum) for the summer season (JJAS) of Bhutan from 1996 to 2021.

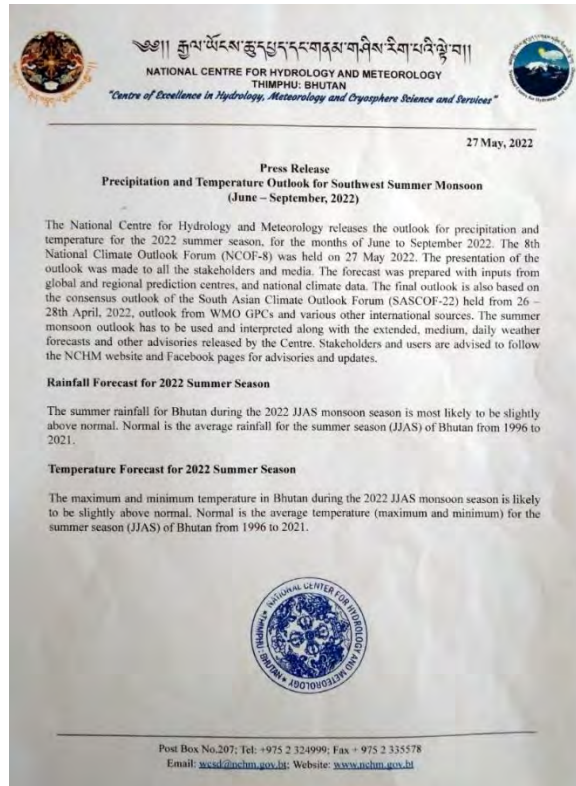


Figure 13: Press release issued for JJAS, 2022



Figure 16: NCOF-9 Forum Participants at Punakha, 27 May 2022

9.8 AGRO-METEOROLOGICAL SERVICES

The Centre provides weather and climate information to develop agro-met services for farmers. The Center is implementing one component of the GCF Project: **Supporting Climate Resilience and Transformational Change in the Agriculture Sector in Bhutan** to develop and enhance agro-met services and products. The Centre developed the Hydro-met Centralized Database Management System (CDMS) with the support of the project.

With the support of ICIMOD, the Centre developed National Agriculture Drought monitoring system for Bhutan.

<http://tethys.icimod.org/apps/droughtbt/outlook/?d=l1Thimphu&e=mean>

9.9 CLIMATE DATA USERS

The Center is responsible for collecting and maintaining the national climate data repository. The Center provides climate data and information to line agencies, private sector, academic researchers and students, corporate sector, and others based on the request as per “Guidelines on the Exchange and Dissemination of Hydro-meteorological Data and Information (2009)”.

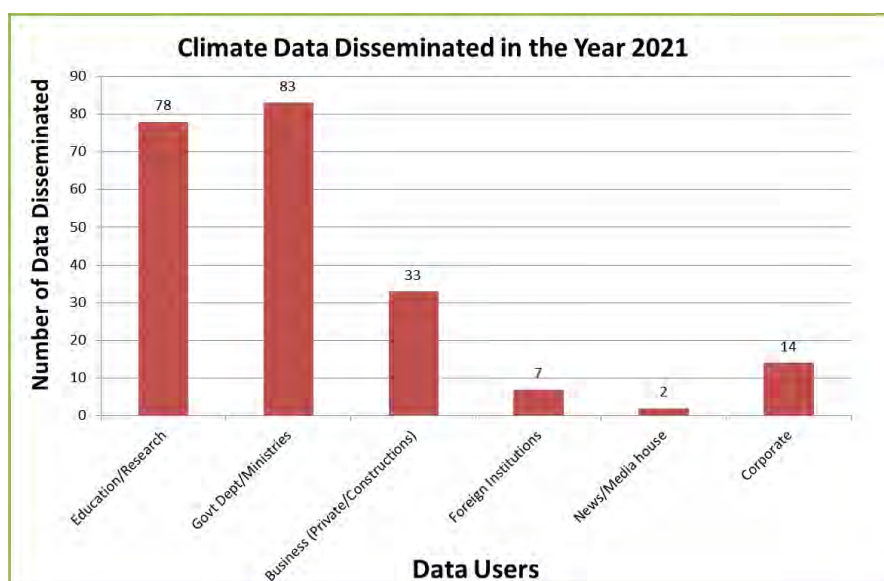


Figure 17 Data request by user for the year 2021.

9.10 AVIATION METEOROLOGICAL SERVICES

The Aviation Met Section maintains and operates airport weather stations at all aerodromes of the country, Paro International Airport and three domestic airports, to provide meteorological information for international and domestic flights as well as for helicopter services.

Aviation Meteorological Section successfully completed the routine as well as ad hoc maintenance of all the weather observation stations in the airports.

9.11 SOP DEVELOPMENT WORKSHOP

A 5 days in-house workshop for “**Development of Standard Operating Procedures (SOP) for effective and timely dissemination of climate and climate risk information at the national and sub-national level**” was held from 9 - 13 May, 2022 under the support of the Project "Supporting Climate Resilience and Transformational Change in the Agriculture Sector in Bhutan" financed by the Green Climate Fund.

The SOP is expected to provide technical guidance and tools for implementing a Quality Management System (QMS) for meteorological services in compliance with ISO 9001:2015 Standard. The workshop was attended by participants from all the sections of WCSD.



Figure 18: GCF Project SOP Development Workshop, NCHM, Thimphu 9-13 May 2022.

10 HYDROLOGY AND WATER RESOURCES SERVICES

12.1 CHANNEL RATING OF AWLS SITES

Stage-discharge rating curves are used to produce most of the world's discharge data. The shape of these curves is dependent on the shape of the channel that controls flow. Changes in rating curves occur over time in response to transitory (e.g., vegetation, ice, debris) or persistent (e.g., aggradation/ degradation) changes of the rated channel which can be natural or man-made. A one-time low flow measurement of the river was carried out along with the channel section to establish rating curve.



Figure 19: Field survey for development of channel rating

The field activities were carried by HWRSD during the FY 2021-2022 for the following AWLS stations.

- a. Dang chhu at Chuzomsa, Wangdiphodrang
- b. Nika chhu at Chendebji, Trongsa
- c. Khagangchhu at Chumay, Bumthang
- d. Dhurchu at Dhur, Bumthang
- e. Tangchhu at Tang, Bumthang

- f. Sherichu at Sherichhu, Mongar
- g. Khomachhu at Lhuntse.

The field activities involved river cross-section surveys for collection of river channel information and characteristics such as channel geometry, bed slope and water surface slope; and flow measurement and river line survey for acquisition of data for calibration of the rating equations.

12.2 AWARENESS ON GLOF/RAINSTORM FLOOD EARLY WARNING SERVICES

Education and awareness of GLOF/Rainstorm Flood Early Warning Systems carried out before the monsoon from May 3-15 May 2022 for the local government officials who were recently elected and the students from the vulnerable schools along Punatshangchu and Chamkhar-Mangdechu basins.



Figure 20: GLOF EWS Awareness with vulnerable communities

12.2 AMMOCHHU FLOOD CONTROL ROOM, PHUENTSHOLING

An interim 24/7 Flood Monitoring Control Room (FMCR) of Amochhu basin set up at DGPC building in 2020. Since the DGPC building is identified as the COVID19 isolation facility as directed by the South COVID-19 Task Force (SC19TF) the Flood Control Room was sifted to YDF building in 2021 from DGPC building. Further control was shifted to CDCL/PTDP staff colony in 2022 as the YDF building resume its maintenance works. Relocation work was carried by a HWRSD Technical Team from 24-30 April 2022.



Figure 21: Relocation of FMCR from YDF building to CDCL/PTDP colony.

10.1 DISSEMINATION OF HYDROLOGICAL DATA

The Centre also provides hydrological data to Government agencies, private sector, academic researchers and students, corporate sector and others private as per the “Guidelines on the Exchange and Dissemination of Hydrometeorological Data and Information” based on the request.

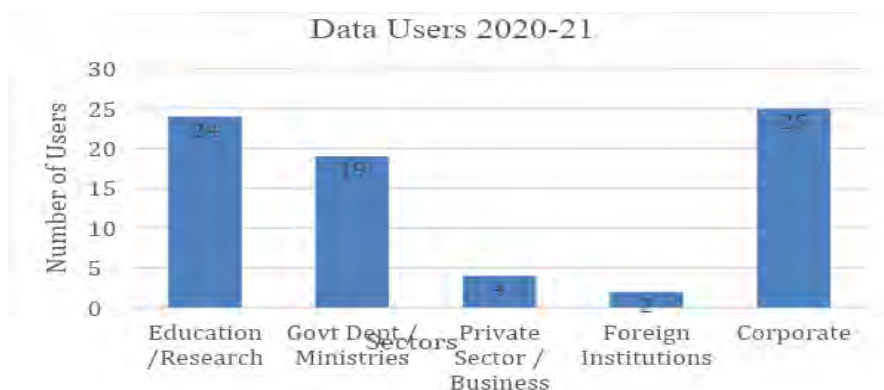


Figure 22:Hydrological data request by different users for the year 2020-2021.

11 NATIONAL HYDRO-MET OBSERVATION NETWORK

11.1 ANNUAL MAINTENANCE OF HYDRO-MET OBSERVATION NETWORK

The Center operates and maintains the National hydro-met observational network that consists of 289 stations across the whole country. The National hydro-met network includes the following:

- Meteorological Station Network
- Hydrological Station Network
- Flood/GLOF EWS
- Flood Warning network supported by GoI.

Table 11: Status and types of hydro-met station

Sl . No.	Type of Monitoring Station	Number
1	Meteorology Station	173
2	Hydrological Station	100
3	Sediment Sampling Station	16
	Total	289

The annual maintenance works of the stations includes, among others, troubleshooting, replacement of sensors/equipment, calibration of sensors, installation and upgradation of selected hydro-met stations. The maintenance team could not cover the stations located along the southern border due to covid-19 restrictions and minor maintenance were carried out by the respective field observers. Annual maintenance works for the national hydro-met observation network was completed and status shown in Table 12.

Table 12: List of stations maintained in 2021-2022

Sl No.	Station Category	Station Type	Total Maintenance 2019-2020	Total Maintenance in 2020-21	Total Maintenance in 2020-21
1	GLOF-EWS	Automatic	15	15	15
2	Hydrological Stations	Manual	19	20	14
		Automatic	42	36	21
3	Meteorological Stations	Manual	20	20	26
		Automatic	82	15	25

The Centre completed annual lean flow measurements of 54 un-gauged streams covering whole country in the month of April 2022.



Figure 23: Selected Photos from Annual Maintenance 2021-2022

11.2 CONSTRUCTION AND RENOVATION OF SITE OFFICES

The following constructions and renovations were carried out by the Centre during the FY 2021-2022.

- a. Construction of Hydrology Site office sum Sediment lab spilled over from 2020-2021 was completed and taken over by Centre on 21 February 2021. M/s SD Construction executed work at the total contract value of Nu. 3,778,048.37.
- b. Renovation of Office Building at Sipsoo completed and work executed by M/s Jinzai Construction and Maintenance Services Construction at the contract price of Nu. 733,123.33/-
- c. Renovation of Office Buildings at Sunkosh completed and work executed by M/s Yoenang, Specialized Firm at contract price of Nu. 2,542,586.40
- d. Renovation of Office Buildings at Chazam completed and executive by M/s Dechen Building Solution, Specialized Firm at Nu. 2,173,174.55
- e. Renovation of Office Buildings at Sershong was executed by M/s Samphel Norbu, Specialized Firm at the contract price of Nu. 1,959,308.92.
- f. Renovation of the Flood Warning Site Office at Thrimshing, Trashigang spilled over to the FY 2021-2022 due to COVID-19 pandemic completed and work executed by M/s Housing and Infrastructure Management Firm at a contract price of Nu. 1,959,308.92/-.
- g. Construction of Flood Monitoring Office of Ammochhu at Gakiling, Sombaykha, Haa awarded to M/s Norzang construction for a contract amount of Nu. 34,65,852.14. Contract terminated and construction work spillover to the FY 2022-2023. Work awarded to new Firm by DNP, MoF.



Figure 24: Photos of new and renovated site offices



Figure 25: AWS at Zanam headwater of Mangdechhu, October, 2022



Figure 26: RCSC Commissioner and Director NCHM with CSD and HOID Team at Rapstreng Tsho, Lunana, September 2022

12 CRYOSPHERE MONITORING AND SERVICES

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 Climate Change.

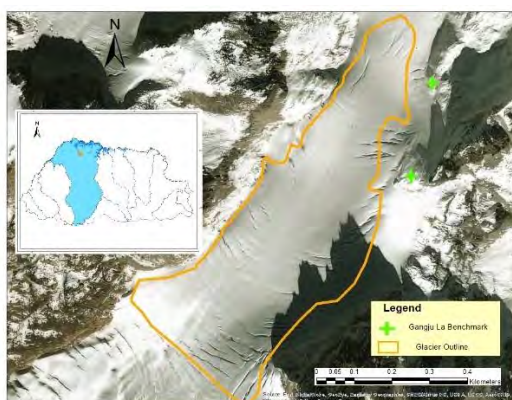
Since there is not much data and information on Bhutan glacial regime, the Centre has established two long term Benchmark glaciers in Bhutan for annual monitoring, viz., Gangju La glacier in the headwater of Pho Chhu Sub-basin and Thana glacier in the headwater of Chamkhar Chhu Sub-basin.

The Cryosphere Services Division is mandated to carry out annual glacier mass balance studies and associate hazards related to glaciers and glacier lakes across the country.

12.1 ANNUAL MONITORING OF BENCHMARK GLACIERS

12.1.1 GANGJU LA GLACIER

Cryosphere Services Division (CSD) team time series monitoring field activity from September 29, 2021 to October 04, 2021. In the glacio-hydrological year 2021-2022 (Autumn Net Balance), Gangju La Glacier continuous to loose mass and also the terminus continues to retreat. The details on the methodologies, data processing, results, and recommendations are compiled in the Technical report on Gangju La Glacier 2020-2021.



Gangjula Glacier facts:

Type: Clean type

Area: 0.3 km²

Location: 27°56'24.17"N,
89°56'53.70"E

Elevation: 5145m a.s.l

Maximum Elevation: 5200m a.s.l

Minimum Elevation: 4900m a.s.l

Basin: Headwater of Pho Chhu,
Punatsang Chhu basin.

Initial Survey: 2004

Status of Study: Ongoing



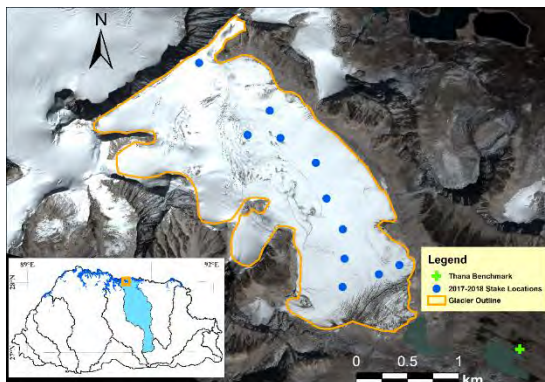
Figure 27:Ganjula Field Activities September 29, 2021 to October 04, 2021

Activities on Gangju la glacier

- Annual Glacier Mass Balance using Geodetic Method (dGPS)
- Snow Depth survey
- Repeat Photography from the predefined spot

12.1.2 THANA GLACIER

Time series monitoring field activity carried out from September 19, 2021 to October 29, 2021. The detailed methodologies, data processing, results, and recommendations are compiled in the technical report titled “Glacier Mass Balance studies on Thana Glacier 2021-2022”.



Thana Glacier Facts:

Type: Clean type

Area: 3.0 km²

Location: 28° 1'17.90"N, 90°36'39.16"E

Elevation: 5340m a.s.l

Maximum Elevation: 5600 m a.s.l

Minimum Elevation: 5250 m a.s.l

Aspect: South-East

Basin: Headwater of Chamkhar Chhu, Manas Basin

Initial Survey: 2013

Status of Study: Ongoing

Activities on Thana Glacier

- Annual Glacier Mass Balance Measurement using stake method
- Annual Glacier Mass Balance using Geodetic Method (dGPS)
- Snow Depth survey
- Repeat Photography from the predefined spot

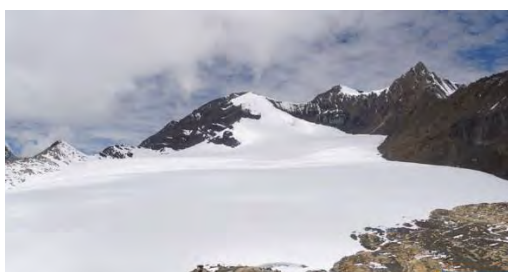
- Discharge measurement at Outlet
- Ice thickness survey using Ice-Penetrating Radar (IPR)



Figure 28: Photos from Thana field activity 2021

12.2 NEW BENCHMARK GLACIER ON THIMCHHU SUB-BASIN

The Cryosphere Services Division (CSD) deployed team to head water of Thimchhu to carry out the field activity from May 1- 27, 2022. Team identified new benchmark glacier (Shodug glacier) for long term monitoring and research for the western region of the country. Team also conducted Ice Radar survey to understand ice thickness along with drone survey during the field activities. The detailed methodologies, data processing, results, and recommendations are compiled in the “Technical report on Shodug Glacier 2021-2022”.



Shodug Glacier Facts:

Glacier type: *Clean ice glacier*
 Location: 27.940 N, 89.950 E
 Elevation: 4900 to 5200 m.a.s.l.
 Area: 3.71 km²
Basin: Headwater of Thimchu
 Wanchu Basin
Initial Survey: 2021
Status of Study: Ongoing

Figure 29: Shogdug Glacier Thimphu basin (2021)

Activities started Shodug Glacier

- Annual Glacier Mass Balance using Geodetic Method (dGPS)
- Snow Depth survey
- Ice thickness survey using Ice-Penetrating Radar (IPR)



Figure 30: Field survey work in Shodug Glacier 2022

12.3 GEOTECHNICAL ASSESSMENT THORTHORMI-RAPTSEHING MORaine

Cryosphere Services Division (CSD) in collaboration with Department of Geology and Mines (DGM) carried out geophysical study from October 4, 2021 to October 24, 2021 in Lunana for understating the geomorphological settings of the moraine Dam between Thorthromi and Rapstreng glacial lake. The Center involved experts and geophysics equipments from DGM to train the CSD staff to strengthen the HR capacity of the Centre in conducting subsurface studies (Geophysical). The team conducted an electric resistivity tomography (ERT) survey of the Thorthormi-Raphstreng moraine barrier and collected other information to assess the potential hazard of the lakes. The detailed methodologies, data processing, results, and recommendations are compiled in the technical report “Time Series Monitoring of Thorthormi glacial lake in the Headwater of Pho-Chhu October 2021-2022”.



Figure 31: Electric resistivity tomography survey, Lunana 2021

12.4 TIME SERIES MONITORING OF GLACIAL LAKE IN ZANAM AREA

During the FY 2021-2022, a field expedition was conducted in the head water of Mangde chu sub-basin from October 25, 2021 to November 2, 2022. The team conducted a bathymetry survey of two 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 Zanam glacial lake in the Headwater of Mangdue-Chhu October 2021-2022.

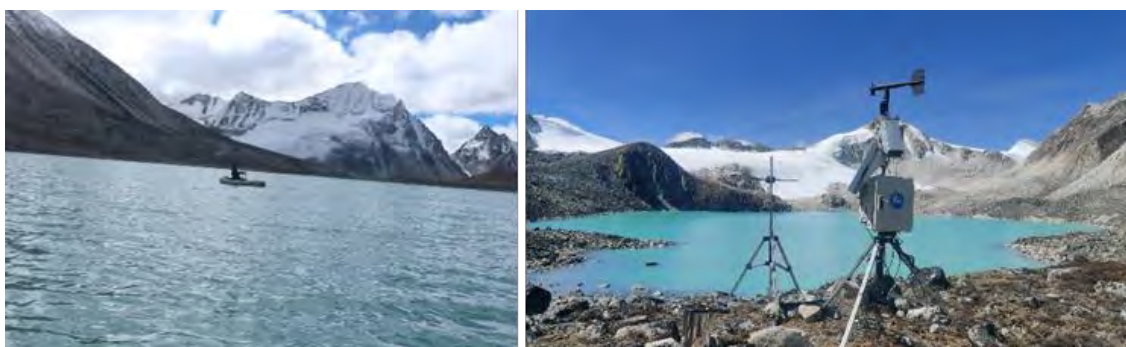


Figure 32: Bathymetric survey of lake and AWS at Zanam, head water Mangdechhu

13 PUBLICATIONS AND REPORTS

The Center is responsible to collect scientific data and carry out research to provide information 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 2021-2022. The reports can be access from Center website page: www.nchm.gov.bt. The documents and scientific reports were launched during the 8th Governing Board Meeting of the Centre held in 28 June 2022.

- a. Revised Structure, Mandates and Functions (2022)
- b. Competency Based Framework (CBF) for Hydrology Officer and Meteorology Officer (2021)
- c. Guidelines and Procurement Procedures for Uniform, Extension Kits and Safety Gears 2021
- d. Guidelines for Publication of Bhutan Hydro-Met Journal (2022)

Scientific and Technical Publications includes the following.

- a. Bhutan Hydro-Met Journal (2022)
- b. Climate Data Book of Bhutan 2022
- c. State of the Climate, 2021

- d. Compendium of Climate and Hydrological Extremes in Bhutan (2017-2021)
- e. Compendium of Snowfall incidences for Bhutan since 1968 (2022)
- f. Glacier Atlas of Bhutan 2022
- g. Surface Hydrology Data Book of Bhutan, 2021



Figure 33: NCHM Publications 2021-2022

14 PROJECTS

14.1 1ST JCC MEETING FOR JICA TCP PROJECT PHASE II

JICA TCP Project for Capacity Enhancement of weather Observation, Forecasting, Flood Warning and Disaster Preparedness and Response in the Thimphu and Paro River Basin started in August 2020 but the implementation got delayed due to COVID pandemic. The project 1st Joint Coordinating Committee (JCC) meeting was held on June 9, 2022 in Thimphu. The project period is extended to September 2024.



Figure 34: JICA TCP Project 1st JCC meeting 9 June 2022, Thimphu

14.2 GCF PROJECT

The Center is one of the implementation partners of the GCF project “Supporting Climate Resilience and Transformational Change in the Agriculture Sector” started in 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 agro-met services. Implementation of some of activities got delayed due to the COVID pandemic.

The development of Hydromet Centralized Database Management System (CDBMS) was awarded to M/s *MicroStep*, Slovakia company but work got delayed due to the pandemic. The supply of hardware and software of the database system was completed and on-line conducted from 27 June 2022 - 1 July 2022, physical training conducted by the Firm in Bhutan in the 11-27 July 2022 in Bhutan.

An additional fund was secured from GCF supported National Adaptation Plan (NAP) project implemented by UNDP/NEC for development of additional components of the Centralized database (hydrology, EWS and cryosphere components) and tendering floated by the UNDP and will carry out in the next FY 2022-2023.



Figure 35: ICT Hardware of Hydro-met CDMS

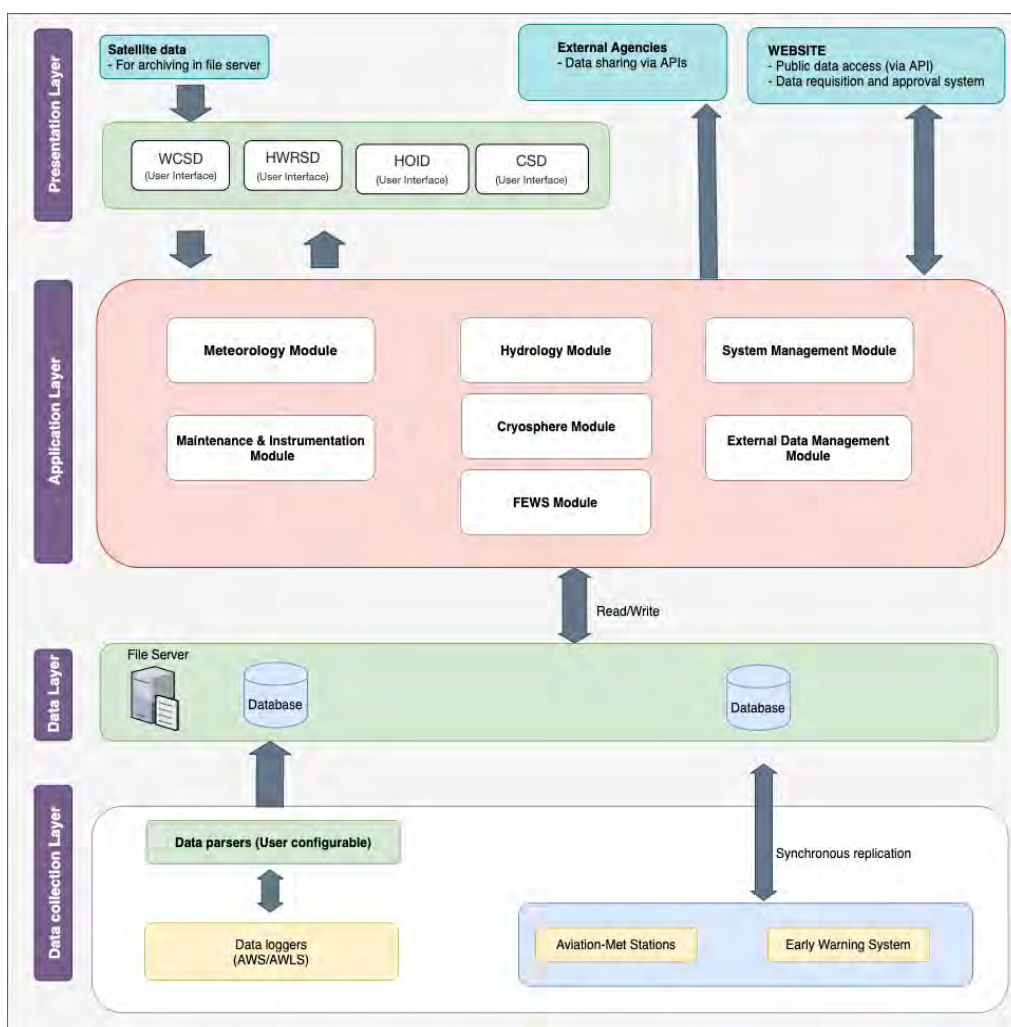


Figure 36: Architecture of Hydro-met CDMS

14.3 WMO PROJECT

WMO project “Developing Capacities for Effective Climate Services in Bhutan” is supported by Korean Meteorological Administration (KMA) in kind (CHF 127,389.00) through WMO (2021-2022). The project is implemented by NCHM and RIMES. The project activities were completed and a dedicated Climate Services tools platform (CST-Bhutan): <http://cst-bhutan.rimes.int/> was developed by RIMES. NCHM in collaboration with

RIMES will carry out the awareness and education activities with stakeholders in July 2022.

14.4 NCHM ICIMOD BRIDGING PROGRAM 2021

NCHM-ICIMOD bridging program assisted NCHM and developed:

- a. Flash flood forecasting and early warning systems (HIWAT-SPT) developed and operational.
<http://tethys.icimod.org/apps/streamflowbhutan/>
- b. Drought Monitoring system for Bhutan developed and operation (Beta Version)
<http://tethys.icimod.org/apps/droughtbt/outlook/?d=11Thimphu&e=mean>

ICIMOD has also provided internship for 2 participants for the Centre to study Glacier Mass Balance Modeling through Machine Learning for a period of 3 months (April-June 2022) but could not send the participants due to COVID pandemic travel restriction.

14.5 WORLD BANK PROJECT

The implementation of the World Bank project “Strengthening Risk Information for Disaster Resilience in Bhutan (RIR, P175081, 2021-2023)” delayed due to delay in signing of Project Agreement and fund disbursement by World Bank. An amount of USD 651,000.00 fund is allocated for the Centre to implement the following activities.

- Flood Risk Assessment
- Support for Hydro-met policy and road map
- Support to develop technical guidance for the Construction of NWFWC,
- Medium range weather forecast (Agro-met)

Under same the RIR project, the World Bank has allocated additional funds of USD 332,733.00 to the Centre to strengthen cryosphere monitoring and risk assessment.

14.6 ESTABLISHMENT OF COMPREHENSIVE FLOOD FORECASTING AND EARLY WARNING SYSTEM FOR AMOCHHU BASIN

The site assessment for setting up comprehensive Flood EWS on Ammochhu basin was completed but the work got delayed due to COVID19 pandemic.

The Center has acquired 13 decimal land for the construction of a permanent Flood Monitoring Control Room at Phuntsholing.

14.7 BHUTAN FOR LIFE (BFL) PROJECT

The Centre in collaboration with Department of Forest and Park Services (DoFPS) under GCF supported BFL project installed four Automatic Weather Stations (AWS) for long term climate monitoring at following places during the FY 2021-2022.

- a. Boomdeling RNR Center (T/yangtse),
- b. Singye Dzong (Lhuentse) and
- c. Khotakha (Wangdue Phodrang)
- d. Gangjula glacier (Gasa)

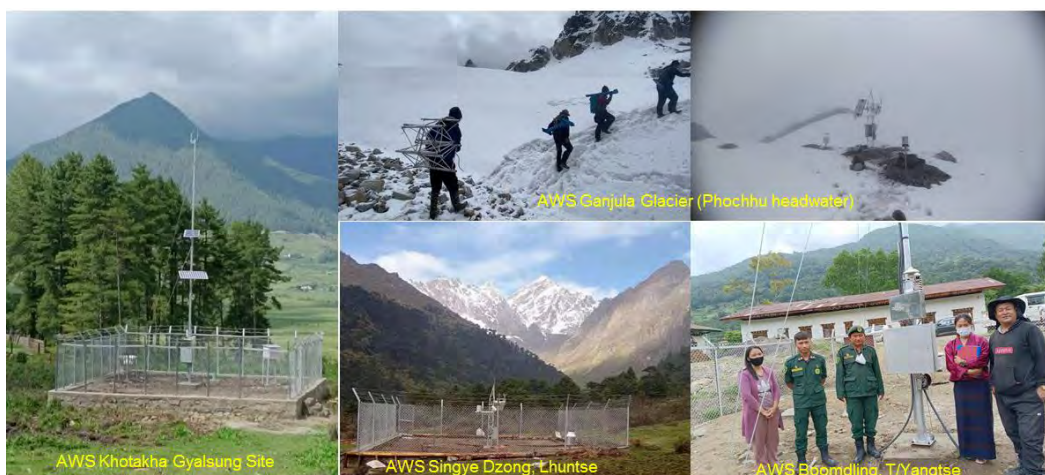


Figure 37: AWS installed under support BFL/GCF project

14.8 NCHM SAP PROJECT CONCEPT NOTE TO GCF

The NCHM has submitted SAP project Concept Note (CN) on “Building Resilience to High-Impact Hydro Meteorological Events through the Strengthening of Multi-Hazard Early Warning Systems in Bhutan” to GCF in November 2019.

With the support of WWF (AE), Regional Integrated Multi-hazard Early Warning System (RIMES) and experts from Institute for Global Environment Strategies (IGES) have been working on revision of project Concept Note

(CN) based on the comments received from GCF. However, WWF Bhutan has withdrawn as the AE from the project and the Centre has written to GNHC to identify a new AE for further development of the project proposal for submission to GCF.

15 INSTITUTIONAL LINKAGES AND COLLABORATION

15.1 MoU BETWEEN NCHM AND CST

A Memorandum of Understanding (MoU) between the College of Science and Technology (CST) and the National Centre for Hydrology and Meteorology (NCHM) for “Joint Research Collaboration on Weather, Climate, Cryosphere, Hydrology and Water Resources in Bhutan” was signed on April 13, 2022. The President, CST and the Director, NCHM signed the MoU virtually. MoU is expected to further promote exchange of experts, know-how and technology transfer, guest lectures and student internship, joint workshop and seminar etc. in the area of mutual interest.



Figure 38: Signing of MoU between NCHM and CST, 13 April 2022

15.2 MoU BETWEEN NCHM AND DoFPS

A Memorandum of Understanding (MoU) was signed on 27 April, 2022 between the Department of Forest and Park Services (DoFPS), Ministry of Agriculture (MoA) and the National Centre for Hydrology and Meteorology (NCHM) for the “Long-term Climate Monitoring within the State Reserved Forests of the Kingdom of Bhutan”.

Under this partnership, NCHM will provide the technical support and the DoFPS will carry out observation and minor maintenance through the concerned Forest and Park Offices to ensure sustainable data collection. MoU is expected to promote partnership and collaboration between two agencies in climate change research and other areas of mutual interest.



Figure 39: Signing of MoU between Director NCHM and Director DoFPS, 27 April 2022

15.3 INTERNSHIP FOR STUDENTS

15.3.1: Sherubtse College Students

Five third year students from Sherubtse College, Royal University of Bhutan joined the Centre on 11 December 2021 for a month-long internship. They are final year students undertaking the B.Sc in Geography and B.sc in Environmental Studies were placed in Cryosphere Services Divisions and undertook the research work on glaciers and glacial lakes. They were introduced to new statistical tools such as R, python, GIS and were given hands- on experience on google earth engine.



Figure 40:: Sherubtse and CNR Interns at NCHM

15.4 STUDENT STUDY VISIT TO NCHM

37 first year students undergoing B.Sc Environment and Climate Studies at the College of Natural Resources (CNR) visited GLOF EWS Control Room, Wangdue and NCHM, HQ on 20th May, 2022. The students and faculty were welcomed to the Centre by Offtg. Director. In the morning, the students were given brief overview presentation on NCHM structure, mandates, functions, hydro-met observations and services provided by the Centre. The students also visited the National Weather and Flood Warning Centre (NWFWC) to see and learned about the weather forecasting and flood monitoring. The educational visit concluded with a visit to Class A Meteorological Station at Babesa.



Figure 41: Photos CNR Study visit to NCHM, HQ and Meteorological Station

16 INSTITUTIONAL STRENGTHENING OF HYDRO-MET SECTOR

16.1 HYDRO-MET POLICY FORMULATION

The stakeholder consultation of the Draft Hydro-met Policy of Bhutan was delayed due to late disbursement of World Bank Project funds and COVID lockdown (Jan-March 2022). A preliminary consultation with key stakeholders was conducted during the National Climate Outlook Forum (NCOF) held on 27 May 2022.

An amount of US 25,000.00 is allocated by World Bank for drafting of policy and carry out consultations with sectors under the Project “Strengthening Risk Information for Disaster Resilience and in Bhutan (RIR, 2021-2023)” and consultation will start from July 2022 (FY 2022-2023).

16.2 INTERNAL REORGANIZATION OF NCHM PROPOSAL

The Center carried out internal reorganization to streamline functions within the Center for effective utilization of manpower with the following objectives:

- a. To improve the center’s capacity/competency 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 employees and
- d. To align organization structure and functions with strategy and long-term goals for the effective delivery of services.

A proposal for internal reorganization of NCHM was submitted in November 2021 and the following were approved by RCSC.

- a. Closure of Regional Office (EAST), Mongar
- b. Dissolution of Hydro-met Observation and Infrastructure Division (HOID),
- c. Creation of Technical Standard and Research Division (TSDR), and
- d. Entry levels for Hydro-met Technician from Class XII General (S-5A) to TT Graduates (S-3A)

16.3 LAND ACQUISITION FOR NCHM OFFICE AND SCIENTIFIC FACILITIES

The Centre has identified an alternative land for construction of NCHM Office and Scientific facilities at Yusipang under Chang Gewog, Thimphu Land is under process with Thimphu Dzongkhag.

World Bank under the project “Strengthening Risk Information for Disaster Resilience in Bhutan Project (2021-2025)” allocated USD 80,000.00 for development of Guidance Note for the Construction of NCHM HQ and scientific facilities. International Consultant recruited by the World bank and the consultant for development of Guidance note and will visit Bhutan in August 2022.



Figure 42: Location of NCHM HQ and Scientific facilities area in Yusipang, Thimphu

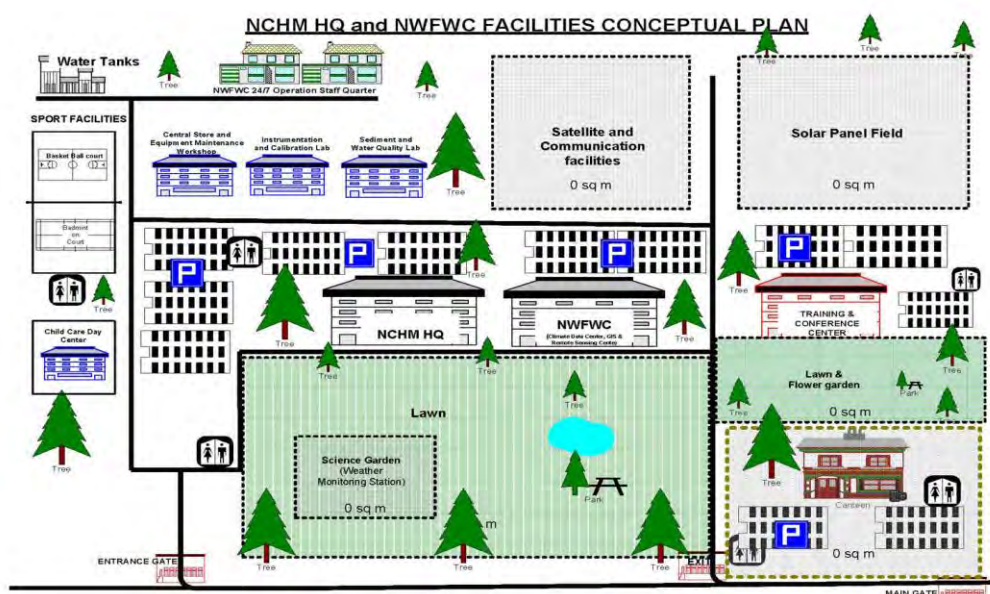


Figure 43: Conceptual Plan for NCHM HQ and NWFWC facilities

17 GOVERNING BOARD MEETING

17.1 7TH GOVERNING BOARD MEETING

The 7th Governing Board meeting of the Center was held on June 24, 2021 at Mayto Hotel, Thimphu. The meeting reviewed the Center's programs and plans. The Center presented the following.

- Annual Plan Target (APT) achievements for the Financial Year 2020-2021,
- APT for the FY 2021-2022 and
- Draft Hydro-met Policy of the Kingdom of Bhutan



Figure 44: 7th GB meeting held on June24,2021

17.2 8TH GOVERNING BOARD MEETING

The 8th Governing Board (GB) meeting of the Centre was convened at Norkhil Boutique Hotel, Thimphu on 28 June 2022. The meeting reviewed the Center's programs and plans. Board also endorsed the Guidelines for Publication of Hydro-met Journal of Bhutan and Guidelines and Procedures for Uniforms, Extension Kits and Safety Gears for the Centre.

The Center also presented the following technical study results of:

- a. Geotechnical Assessment of Thorthomi moraine, Lunana 2021,
- b. New Benchmark Glacier in Thimchu headwater for long term monitoring and research

Dasho Secretary, NEC/Chairman of NCHM Governing Board launched the Centre Publications for the FY 2021-2022 including the Bhutan Hydro-met Journal started in 2022.



Figure 45: 8th GB meeting, 28 June 2022, Thimphu, Bhutan

18 WMO AND IPCC MEETING

18.1 WMO EXTRA ORDINARY SESSION 11-14 OCTOBER 2021

World Meteorological Organization (WMO) Extraordinary Congress Session (Cg-Ext 2021) was held prior to the COP26, to strengthen action on water and climate to improve data exchange and early warning services in the view of mounting challenges of climate change. The online session was held from 11 October 2021 and opened by the WMO President, Professor Gerhard Adrian and with keynote addressed by Mr. Alain Berset, Federal Home Affair Minister, Switzerland, Director General, United Nations Office at Geneva, Secretary General, WMO and Special Representative of the Secretary General for Disaster Risk Reduction (UNDRR). The session ended on 14 October 2021. More than 515 delegates from the Member States and international organizations attend the opening session.

As a focal point of Bhutan with WMO, the Director, NCHM/Permanent Representative (PR) of Bhutan with WMO and Mr. Tayba Buddha Tamang, Chief from the Center is attending the Session.

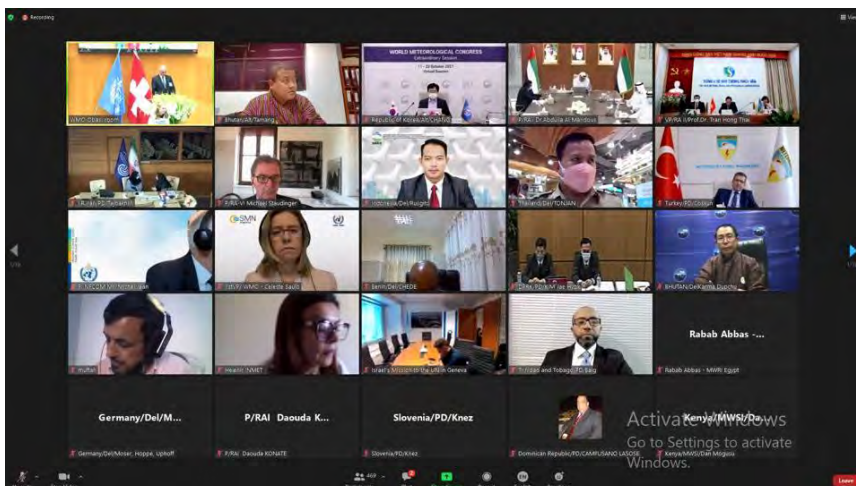


Figure 46: Extraordinary Congress Session (Cg-Ext (2021) WMO, 11-14 October 2021

18.2 INTERGOVERNMENTAL PANEL FOR CLIMATE CHANGE (IPCC)

The National Center for Hydrology and Meteorology (NCHM) as the designated National Focal of Bhutan with IPCC attended the following meetings during the FY 2020-2021 with funding from the IPCC Trust.

Table 14: List of IPCC meeting

Sl. #	IPCC Meeting	Date
1	Mr. Tayba Buddha Tamang, Chief of HWRSD and Dr. Om Katel, Lecturer of College of Natural Resources (CNR) attended the Fifty-Sixth Session of the Intergovernmental Panel on Climate Change (IPCC-56) and 14 th Session of Working Group III (virtual). The meeting finalized and released the Report Climate Change 2022: Mitigation Climate Change	21 March - 3 April 2022
2	Dr. Singay Dorji, Specialist, NCHM attended the Fifty-Fifth Session of the IPCC (IPCC-55) and 12th Session of Working Group II (Virtual)	14-26 February 2022
3	Mr. Tayba Buddha Tamang, Chief of HWRSD and Dr. Om Katel, Lecturer of College of Natural Resources (CNR) attended the Fifty-Fourth Session of the Intergovernmental Panel on Climate Change (IPCC-54) and 14th Session of Working Group I (Virtual)	26 July - 6 August 2021

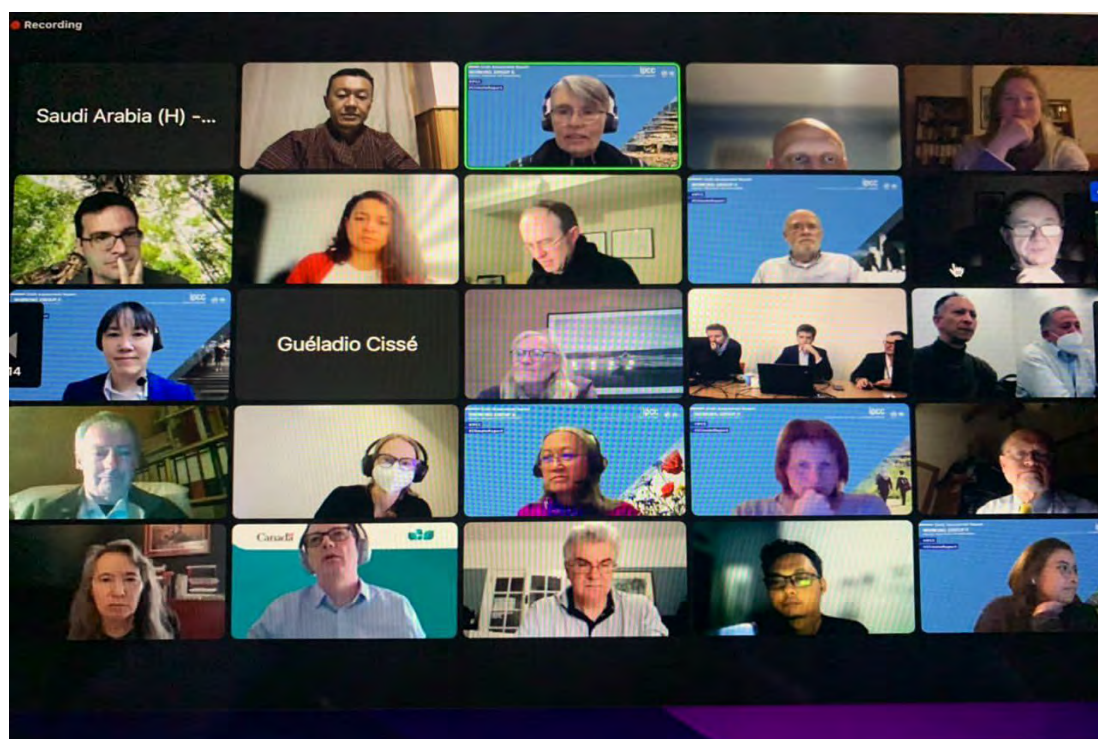


Figure 47: Dr. Singay Dorji, Specialist, NCHM attended the Fifty-Fifth Session of the IPCC (IPCC-55)

18.3 WMO LEADERSHIP AND MANAGEMENT PROGRAM FOR SENIOR MANAGEMENT OF NMHS, 3-13 AUGUST 2021

The Third World Meteorological Organization (WMO) Leadership and Management Programme for Senior Management of National Meteorological and Hydrological Services (NMHS) started virtually on 3 August 2021. The two weeks course was jointly organized by WMO and Meteorological Services Singapore (MSS) in collaboration with Lee Kuan Yew School of Public Policy (LKYSPP) of the National University of Singapore from 3-13 August 2021.

Dr. Singay Dorji, Specialist/Chief, Weather and Climate Services Division (WCSD), NCHM attended the training with participants from all six WMO Regional Associations (RAs).

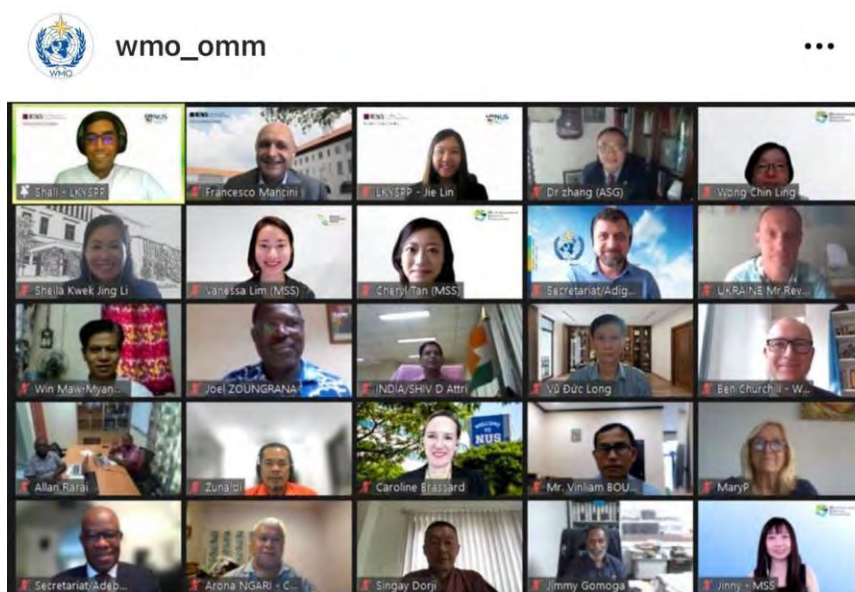


Figure 48: Photo Courtesy @WMO opening ceremony.

19 IMPORTANT EVENTS

19.1 ENVIRONMENT AND CLIMATE CHANGE COMMITTEE OF NATIONAL ASSEMBLY VISITED NCHM, 16 JULY 2022

The Environment and Climate Change Committee (ECCC) members of the National Assembly (NA) led by the Chairperson, Hon. Gyambo Tshering visited the Center on 16 July 2021. Prior to consultation meeting the Hon'ble members visited the 24/7 National Weather Forecasting and Warning Center

(NWFWC) and its facilities. The NWFWC is the main supervisory and command center of NCHM for 24/7 monitoring and dissemination of weather, climate and flood information and warnings to line agencies and public. During the meeting NCHM presented the following;

- a. An overview of NCHM structure, functions and institutional linkages, 12 FYP, Issues and challenges;
- b. Bhutan State of Climate 2020 and climate projection results.
- c. State of the Glaciers and Glacier Lakes in Bhutan;
- d. Results of two Long-term Monitoring Bench Marked Glaciers of Bhutan (2020) and Glaciers melt contribution to the river flow in Bhutan;
- e. Status of Flood/GLOF Early Warning Systems in Bhutan

The meeting also discussed the need of Hydromet Policy and Hydro-met Act of Bhutan. The meeting with NCHM was called by the ECCC Committee, NA to understand about the Center and also to seek feedback of the draft Biodiversity Bill of Bhutan 2021.



Figure 49: NCHM meeting with ECCC, NA, 16 July 2021

19.2 ORIENTATION PROGRAM

Ms. Phuntsho Wangmo, Civil Engineer joined the Center on 6 August 2021 as a Meteorology/Hydrology Officer under the Hydrology and Water Resources Services Division, NCHM. A day long generic orientation program about the Center's vision and mission, organization structure, mandates functions and related BSCR was conducted on 9 August 2021.



Figure 50: NCHM team with Ms. Phuntsho Wangmo, new Meteorology/Hydrology Officer

Ms. Tshering Lhamo and Ms. Ugyen Lhamo, Meteorology/Hydrology Officer joined the Centre in January 2022. Due to lockdown, e-Joining Session was conducted by Centre on 25 January 2022.



Figure 51: e-joining session for new technical graduate, 25 January 2022

Ms. Tshering Lhamo has completed Bachelors of Science in Atmospheric Science from Nanjing University of Information Science and Technology, China under WMO Scholarship and Ms. Ugyen Lhamo completed Bachelors of Science in Meteorology and Climate from University of Reading, United Kingdom.

19.3 RCSC COMMISSIONER AND DIRECTOR FIELD MONITORING VISIT TO LUNANA

The Director along the Commissioner from RCSC visits Lunana from 12 September 2021- 3 October 2021 along with Cryosphere Services Division (CSD) and GLOF EWS maintenance team with following objectives.

- Familiarization of glaciers and glacier lakes of Bhutan Himalayan
- Monitoring of high-altitude field work carried out Cryosphere Services Division (CSD) and GOLF EWS monitoring network station and facilities and
- Understanding the issues and challenges



Figure 52: RCSC Commission and Director NCHM visited Lunana in September 2021

Based on observations and discussion with staff and other civil servants, the following are recommendations were taken up with relevant authorities.

- Access and extend Helicopter Services to civil servants working in Lunana and other high-altitude areas to motivate and enhance service delivery and human and animal drudgery. (**Action:** NCHM took up issue with the Cabinet Secretary. Approval granted the Cabinet to use Helicopter Services by NCHM and other civil servant working in high altitude activities.
- Land acquisition for relocation of the Flood Warning Office, Thangza for effective monitoring and issuing of warnings. Also, to accommodate space for a dedicated store and communication facilities. (**Action:** 50

- decimals land acquired and fund request for construction of Flood Warning Office submitted to Bhutan For Life (BFL) GCF project.*
- c. Proposal for revision of Special allowance for NCHM staff working in Lunana and cryosphere monitoring works. (**Action:** *Proposal submitted to MoF. MoF defer proposal to next Pay commission*)
 - d. Provide safety training and necessary safety gear for staff working in glacier and glacier lakes monitoring and assessment.

19.4 WORKSHOP ON BUILDING EMOTIONAL INTELLIGENCE 4-5 OCTOBER 2021

The National Center for Hydrology and Meteorology (NCHM) in coordination with the Royal Civil Service Commission (RCSC) conducted two days' workshop on "Building Emotional Intelligence: Search Inside Yourself (SIY)" in Thimphu from 4-5 October 2021. 44 employees of NCHM in Thimphu attended the session. The workshop was facilitated by certified SIY resource person: Mr. Ugyen Tenzin, Vice Principal, Babesa HSS and Ms. Zangmo, Teacher, Zilion Namgyeling School, Thimphu. The closing session was graced by Dasho Dhanapati Mishra, Focal Commissioner, RCSC on 5 October 2021.



Figure 53: NCHM SIY Session

19.5 FAO REPRESENTATIVE OF BHUTAN AND NEPAL COURTESY VISIT TO CENTER

Mr. Ken Shimizu, FAO Representative of Bhutan and Nepal courtesy visit to the National Centre for Hydrology and Meteorology (NCHM) on 8th June, 2022. The Centre made a brief presentation about NCHM and its roles in hydro-met data collection and effective delivery of services for planning appropriate adaptation and mitigation measures against Climate Change impacts. FAO and NCHM also discussed potential areas of collaboration in future. He also visited the 24/7 National Weather and Flood Warning Centre (NWFWC).

Mr. Ken appreciated the work and services provided by the NCHM and looks forward to working with the Centre.



Figure 54: NCHM Management with FAO Representative of Bhutan and Nepal

19.6 CIVIL SERVICE AWARD CEREMONY 2021

The Civil Service Award Ceremony for the Center for the year 2020 was held on 15 December 2021 at the Energy conference hall. A total of 24 employees of the Centre received the Civil Service Awards as detail given in table below.

Sl No.	10 years (Bronze)	20 Years (Silver)	30 Years (Gold)	Lifetime
1	9	11	2	2

Along with Dedicated Civil Services Awards for 16 employees, the Centre also awarded:

- d. Certificate for five Outstanding employees for the FY 2021-2022 and
- e. Promotion order for 37 employees promoted from January 1, 2022.



Figure 55: Recipients of Awards and promotions 2021

19.7 NATIONAL ORDER MERIT GOLD TO MR. KARMA, SPECIALIST

His Majesty the King conferred the National Order of Merit (Gold) to Mr. Karma Toeb, Specialist, National Center for Hydrology and Meteorology (NCHM) during the 114th National Day at Trashichhodzong, Thimphu.

Mr. Karma was received in the office by the management and employees of the Centre in the afternoon 17 December, 2022 and offered Trashi Khadar for the recognition of his exemplary services to the nation.

Glaciologist Toeb Karma earns top National Merit Award

Since joining the civil service as a glaciologist in 1997, Toeb Karma spent over two decades working to mitigate the risk of Glacial Lake Outburst Floods in Bhutan.

He has led several teams to study and monitor glaciers in the most difficult parts of the country and helped develop a comprehensive inventory of glacial lakes in Bhutan including those that pose the greatest risk to lives and livelihoods downstream.

Between 2008 to 2012, he led a team to lower the water level of Thorthomi Lake in Lunana- a challenging but important project which has greatly helped mitigate the risk of flood posed by the lake.

In 2021, he revised the inventory on glaciers in Bhutan using the high-resolution satellite images and RADAR data and published the "Bhutan Glacial Lake Inventory 2021".

Yesterday, during the celebrations of the National Day, His Majesty The King conferred Toeb Karma the National Order of Merit, Gold.

Toeb Karma, Specialist and Head of Cryosphere Service Division of the National



Hydrology and Meteorology Centre, was recognised for his exemplary services to the nation through his work in preparing for climate-change-related risks.

Toeb Karma graduated with a Bachelor's Degree in Geology from Jadavpur University in India in 1996 and MSc in Glaciology from Nagoya University in Japan in 2001.



Figure 56: NCHM reception of Mr. Karma after the receiving the Award (Photo Courtesy Kuensel)

19.8 OBSERVING ZERO WASTE HOUR

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 the month is observed as the Zero Waste Hour. The Center has made mandatory for the HQ and all the site's offices to observe the Zero Waste Hour every month by cleaning the office surroundings and hydro-met stations throughout Bhutan.



Figure 57: Selected photos Zero Waste Hours from NCHM HQ and field office/Station

20 HUMAN RESOURCES DEVELOPMENT

20.1 SHORT TERM TRAINING (STT)

Despite travel restrictions during the FY 2021-2022, the employees have attended various online trainings, meetings and seminars with the support from international, bilateral, regional partners and projects to enhance the professional capacity and to keep abreast with emerging technology. The Centre during the span of one year has facilitated to attend 37 trainings, meeting, seminars and workshops for 67 individual employees as detailed below;

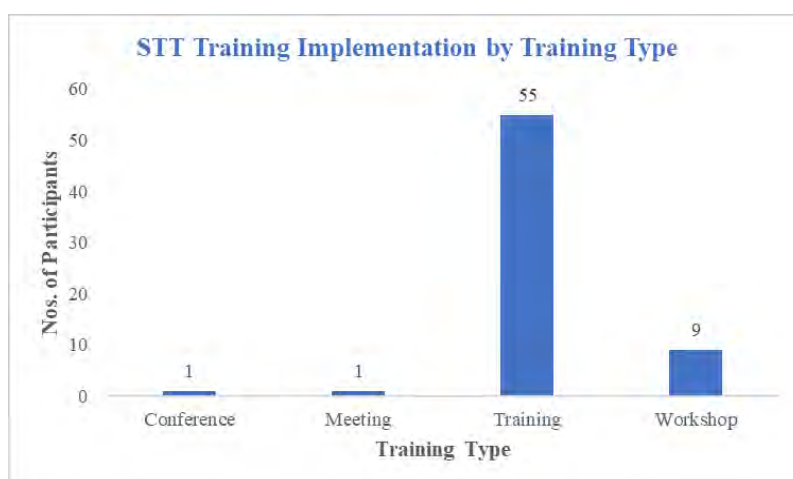


Figure 58 Types of STTs attended for the FY 2021-2022

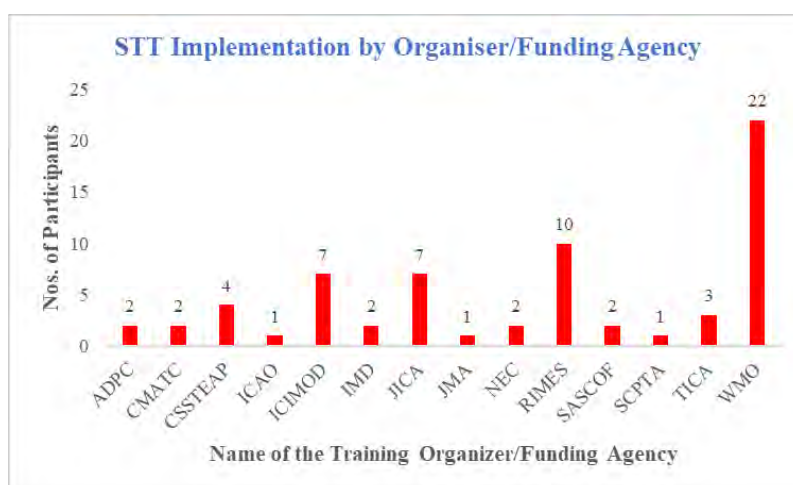


Figure 59: STT with donors/funding agency

20.2 MANDATORY MEETING/WORKSHOP/CONFERENCE

The NCHM is designated as the national focal point of Bhutan with WMO, IPCC, ICAO and other regional organizations. Four officials from the Centre attended eight mandatory meetings/seminars and workshops of IPCC, WMO, RIMES and ICAO for financial year 2021-2022 as detailed in the table below.

Table 5: List of mandatory/important virtual meetings/seminars attended

Sl#	Name of the Delegation	Position Title	Title of the Meeting/Seminar/Conference	Nos. of Delegation	Date	Organiser/ Funding Agency
1	Tayba Buddha Tamang	Chief Met/Hyd. Officer	Fifty Fourth Session of the IPCC (IPCC-54) and Fourteenth Session of the Working Group I (WGI-14)	1	26 Jul- 6 Aug 2021	IPCC
2	Karma Dupchu	Director	Phase 2 of the Seventeenth Session of Regional Association II (Asia) RA II - 17	2	27-30 Aug 2021	WMO
3	Singay Dorji	Specialist III				
4	Karma Dupchu	Director	Delegates for Extraordinary Session of the World Meteorological Congress (Cg-Ext (2021)	2	10-22 Oct 2021	WMO
5	Tayba Buddha Tamang	Chief Met/Hyd. Officer				
6	Karma Dupchu	Director	Annual South Asia Hydromet Forum Conference 2021 (SAHF-III)	1	15-18 Nov 2021	RIMES
7	Tayba Buddha Tamang	Chief Met/Hyd. Officer	13th RIMES Council Meeting (virtual)	1	23-24 Nov 2021	RIMES
8	Sonam Rabten	Sr. Met/Hyd. Officer	Thirty-Second Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/32)	1	30 Nov- 2 Dec 2021	ICAO
9	Singay Dorji	Specialist III	Fifty-Fifth Session of the IPCC (IPCC-55)	1	14-25 Feb 2022	IPCC
10	Tayba Buddha Tamang	Chief Met/Hyd. Officer	Fifty-Sixth Session of the IPCC (IPCC-56) and Fourteenth Session of the Working Group III	1	21 Mar-1 Apr 2022	IPCC

Table 13: List of Important Virtual Meetings/Workshops/Conference attended in the FY 2020-2021

20.3 LONG TERM TRAINING

Currently, the following officials are pursuing long-term studies under various scholarships as detailed in table below.

Table 15: List of Employees on long-term trainings for FY 2021-2022

Sl#	Name/P Title	Course	Institute /Country	Funding
1	Ms. Pema Sylton (Met/Hyd. Officer)	Masters in Counter Measures for Climate Change and Disaster Risk Management	Nagoya University, Japan	JDS
2	Mr. Tandin Wangchuk (Engineer)	Master in Flood Disaster Risk Reduction	National Graduate Institute for Policy Studies, Japan.	JDS

3	Mr. Trashi Namgyel (Executive Engineer)	Masters of Technology (Water Resources and Development)	Indian Institute of Technology Roorkee (India)	Nehru Wangchuck Scholarship
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21 WELLBEING OF STAFF

21.1 NCHM STAFF WELFARE FUND

To strengthen solidarity among the staff and provide financial support in times of need, the Centre established a Staff Welfare Scheme in 2017 with monthly contributions from the members. The membership is open to all the staff of NCHM on a voluntary basis. The Welfare Scheme is managed by the Committee nominated from the members during the Annual General meeting.

21.2 FAREWELL FOR OUTGOING STAFF, 11 JUNE 2022

The Centre organized a simple farewell dinner with gifts to three out-going staffs on 10 June 2022.

- Mrs. Chimi Wangmo, Dy. Chief Finance Officer (2017-March 2022) promoted to the Chief Accounts Officer, Ministry of Finance through open competitive selection.
- Mr. Tshencho Dorji, Executive Engineer served Centre from January 2010. He has voluntarily resigned from service with effect from 1 June 2022 after serving over 10 years under the Weather and Climate Services Division.
- Mr. Birkha Bahadur Gurung has served as Met/Hyd Technician for the last 34 years. He served in his capacity in various hydrological stations across the country and his last posting was at Rapid station, Wangdue.



Figure 60: NCHM bids farewell to outgoing employees

22 CHALLENGES AND ISSUES

Being a 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 the key issues and challenges that need immediate interventions.

- a. Lack of office space and scientific facilities
- b. No Hydro-met Policy and related legislation
- c. Technical nature of job and 24/7 functions
- d. Limited trained technical professional for effective delivery of hydro-met services.
- e. Trained technical professional leaving the Centre and no dedicated ICTO/ICTA to look after the ICT infrastructure of the Centre.

Annexure - I

Table 6: NCHM APT for the FY 2021-202 and Achievements

APT of NCHM for FY 2020-2021 with Achievements as of June 2022					
Objective	Action	Success Indicator	Unit	Planned Activities (June 2021)	Achievements (June 2022)
Hydro-meteorological and cryosphere disasters assessed & reduced	Hydro met and Flood/GLOF warning network enhanced.	The critical hydro-met/GLOF infrastructures & network enhanced & maintained	Number	7	<ol style="list-style-type: none"> 1. Renovation of Meteorological Site Office at Sibsoo, Samtse (Completed); 2. Renovation of FWS Site office at Sershong, Gelephu (Completed); 3. Renovation of FWS Site office at Sunkosh, Tsirang (Completed); 4. Renovation of FWS Site Office building at Chazam, Tashigang (Completed); 5. Construction of new Hydrology Site office and Sediment Lab at Panbang, Zhemgang, (Completed); 6. Construction of new Flood Monitoring and Warning Office at Gakiling, Sombaykha, Haa (spilled over to the FY 2022-2023) due to non-performance of Contractor. Contract terminated and DNP, MoF awarded work to new Build for Bhutan Firm;

					<ul style="list-style-type: none"> 7. Relocation of Class A Station at Zhemgang, (Completed) 8. Upgradation of Class A Station at Chamkhar (Bumthang) and Kanglung (Trashigang) (Completed) 9. Installation of new AWS at Khotokha (Gylasung site), Wangduephodrang (Completed). 10. Relocation of AWS at Bumdeling and Phobjikha. (Completed); 11. Installation of new AWS at Gangjula and Singye Dzong (Completed). 12. Installation of manual snow stations at Soe, Lingshi, Tegola and Pelela (Completed). 13. Annual maintenance works of existing hydromet stations across the country for the FY 2021-2022 (Completed)
	Issue Flood forecast, GLOF/Flood warning/advisories	Flood forecast, GLOF/Flood warning/advisories issued.	Number	2	<ul style="list-style-type: none"> 1. Technical report for the set-up of Hydrological model (HEC-HMS) for Kurichu basin and Punatsangchu basin submitted. 2. Flood/GLOF EWS monitored 24/7 for 365 days information disseminated to line agencies and stakeholder. Flood advisories issued during extreme events

					<ol style="list-style-type: none"> 3. Education and Awareness of flood/GLOF awareness in Punakha-Wangdue valleys, Chamkharchhu carried out for Local Government and vulnerable communities/schools conducted and reports submitted. 4. Flood EWS for Amochu operated during the monsoon. Concept note for the establishment of a comprehensive early warning system at Ammochhu submitted.
	Conduct assessment of hydrological hazard	Assessment of hydrological hazard conducted.		3	<ol style="list-style-type: none"> 1. Technical report on Flood hazard assessment of Thimpchhu in Wangchu Basin; 2. Preliminary flood hazard map (Return period for 14 years, 25 years and 100 years); 3. Hydrodynamic model using HEC-RAS set up and physical verification conducted for selected river basins.
	Assessment and monitoring of cryosphere and associated hazards conducted	Assessment and monitoring of cryosphere and associated hazards conducted	Number	5	<ol style="list-style-type: none"> 1. Monitoring of annual glacier mass balance on the benchmark glaciers (Thana Glacier) completed and submitted on 29th April, 2022. 2. Monitoring of annual glacier mass balance on the benchmark glaciers (Gangju La Glacier) completed and report submitted on 29th April, 2022.

					<ol style="list-style-type: none"> 3. Sub surface assessment of Thorthomi glacial lakes for GLOF risk conducted and report submitted on 31st January, 2022. 4. New Benchmark Glacier (Shogshu) for long term monitoring for Mass Balance on Thim chhu headwater glacier identified and field report submitted on 5th June, 2022. 5. Field Assessment report (2021) of glacial lakes for GLOF risk (Lakes of Zanam region) Annual Time Series Monitoring of Glacial Lakes for Glacial Lake Outburst Flood (GLOF) conducted and submitted on 29th April, 2022.
End-to-end operational National Framework for Climate Services (NFCS)	Issue Weather forecast and advisories on extreme weather events	Weather forecast and advisories on extreme weather events issued	Number	7	<ol style="list-style-type: none"> 1. 24/7 weather monitored for 365 days, forecast and advisors/warning issued. 2. Weather reports shared with to the stakeholders (Royal Office, PMO, Cabinet, Army Disaster Response, DDM, Media, etc. on sub-daily basis. 3. Logbook for operation and maintenance of systems (GTS, HimawariCast, WRF and SmartMet); 4. Extreme weather monitored and advisories issued;

					<ul style="list-style-type: none"> 5. Weather forecast of 8 points (Dzongkhags) prepared and uploaded to WMO Weather Information System (WIS), 6. Medium range weather forecast issued. 7. Synoptic data sent to WMO (physical verification of the system conducted)
	Provide Aviation met services	Aviation met services provided	Number	5	<ul style="list-style-type: none"> 1. Operation of maintenance of aviation met equipment at all airports completed, 2. Meteorological observations and reports (METAR/SPECI) generated every 30 mins and sent to International Civil Aviation Organization (ICAO) 3. Up-gradation of meteorological observation at airports completed. 4. Climatological data for "Aeronautical climatological information" compiled and completed. 5. Briefing register and a sample of briefing for "Services for operators and flight crew members (briefing)" prepared and shared.
	Provide Climate services	Climate services provided	Number	9	<ul style="list-style-type: none"> 1. Eighth National Climate Forum (NCOF-8) conducted on 27 May 2022 at Punakha. 2. Seasonal prediction _summer outlook (Monsoon) for JJAS 2022 and technical note for summer outlook issued with a press release.

					<ol style="list-style-type: none"> 3. Seasonal prediction _winter outlook for DJF 2021-2022 and technical note for winter outlook issued with a press release. 4. Annual climate monitoring (Annual State of the Climate Report-2021) and Climate Data Book 2022 published and released during the 8th GB meeting held on 28 June 2022. 5. Weather and climate information updated on the NCHM website. 6. Monthly climate monitoring report published and uploaded in website. 7. Weather and seasonal information uploaded in the Agro-met Decision Support System (ADSS) of Department of Agriculture for agro-met services; 8. Meteorological data processed and archived in CLIMSOF. 9. Sub-season climate prediction (Extended range) shared.
Access to hydro logical information and understanding of national water availability improved	Generate Mean Annual Flow of River Basins	Mean annual flow of main river basins generated	Number	3	<ol style="list-style-type: none"> 1. Technical report on Water Resource Availability study in Thimchhu basin based on Lungtenphu station hydrological data prepared. 2. Hydrological data processed and archived in the National Hydrological database (HYDATA - Hydrological Data Processing and Database Management) operated by the Centre.

					<ol style="list-style-type: none"> 3. Flow status report for selected river basin and station for the year 2022 prepared. 4. Compendium of Climate and Hydrological Extremes in Bhutan (2017-2021) published and launched during the 8th GB meeting held on 28 June 2022. 5. The flood information for the year 2021-2022 compiled and report submitted. 6. Technical report validation of channel rating equations for 7 AWLS completed and report submitted. 7. Annual Hydrological Data Book (2021) published and launched during the 8th GB meeting held on 28 June 2022. 8. Report on Statistical Comparison of AWLS with Manual hydrological station published. 9. Bhutan Hydromet Journal 2021 published and launched during the 8th GB meeting held on 28 June 2022.
	Monitoring and Transmission of hydro-met data	Monitoring and Transmission of hydro-met data to HQ	Within 25 days		<ol style="list-style-type: none"> 1. Hydro-met station monitored 365 days and Data collected site staff on predetermined time. 2. Data transmitted monthly to HQ for data processing and archival in National Database. 3. Ground verification and monitoring - carried out as per the monitoring reports

Water quality improved	Measurement of suspended sediment loads in major rivers	Measurement of suspended sediment loads in major rivers	Number	1	1. Sediment lab at Kerabari (Karmaling) set up and operational.
To provide effective and efficient admin/HR, ICT, direction and related common support services	Provide effective and efficient directorate & services	Provided effective and efficient directorate & common services	Days	3 working days	2. Testimony for the office orders issued (both in dzongkha and English) within the TAT. 3. ICT services provided 265 day and Server and network operated with minimum disruption for delivery of services.
Transparent, accountable & integrity consciousness and culture strengthened	Enhance integrity system by implementing OIP	Integrity score improved	Percent	50% of OIP Implemented	1. Enforced administrative sanctions 2. Strengthen declaration & management of assets (ongoing) 3. Strengthen declaration & management of COI, gift, COC, GRMC. 4. Integrity Vetting System 5. Conduct ethical leadership training. 6. Implement other integrity and ACC recommendations
To strengthen evidence-based decision and data culture	Promote the use of quality data for informed decision making		Percent	90 and above	1. Hydrological Surface Book of Bhutan (2021) published 2. State of Climate Bhutan (2021) Published.

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