



Korea Meteorological
Administration



WORLD
METEOROLOGICAL
ORGANIZATION



Regional Workshop on Impact-Based Forecast in Asia

Weather forecasting and disaster in Bhutan

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Outline

- Country profile
- Weather forecasting system in Bhutan
- Types of high impact Weather
- Current meteorological alert systems
- Weather warning communication
- Inter- governmental strategy to reduce the damages
- Conclusion

Country Profile

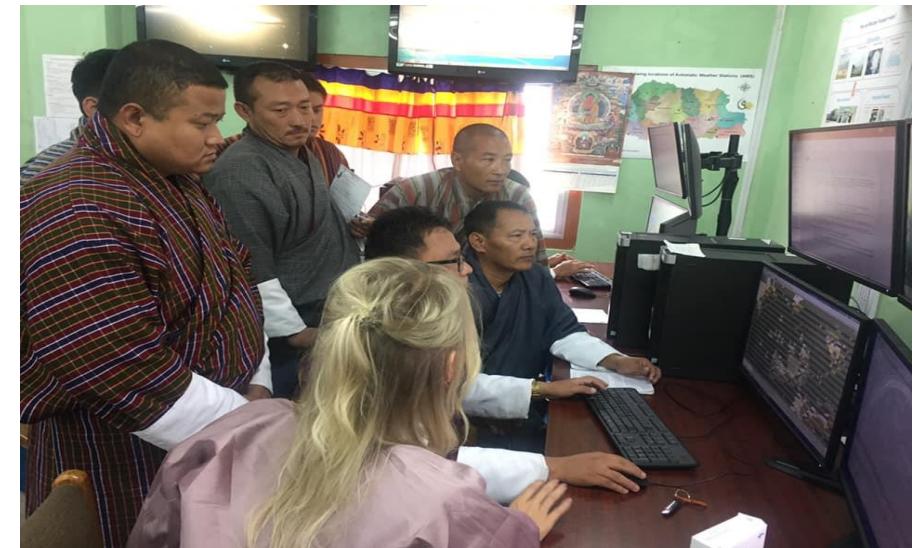
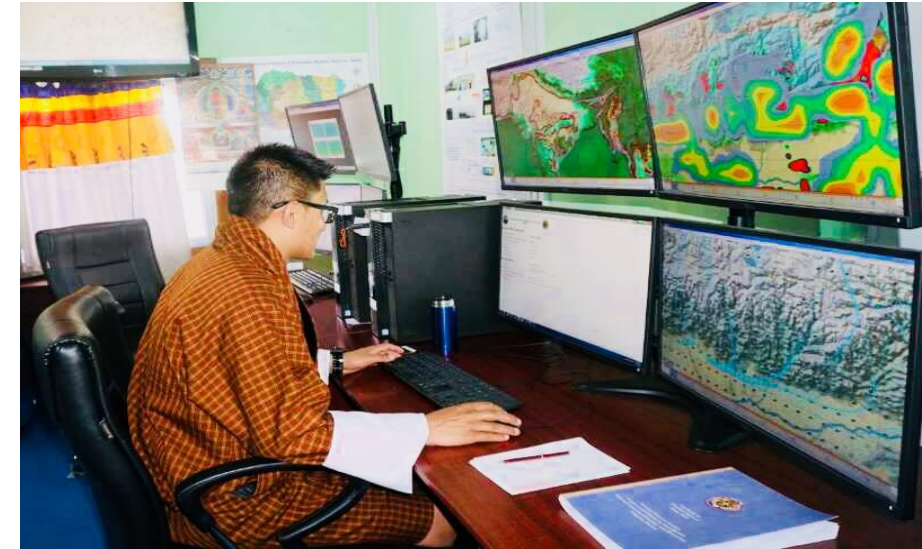
- Total area - **38,394** Sq. Km
- Population – **around 817,054** (2017)
- **79 %** of population is **farmer**
- Altitude : **160 m** to **7500 m** above msl
- Forest Coverage: **70.5%** - Policy is to ensure at least **60%** for all time
- **Politic: Constitutional Monarchy since 2008**



Weather forecasting system in Bhutan

Currently, NCHM Provides the following services;

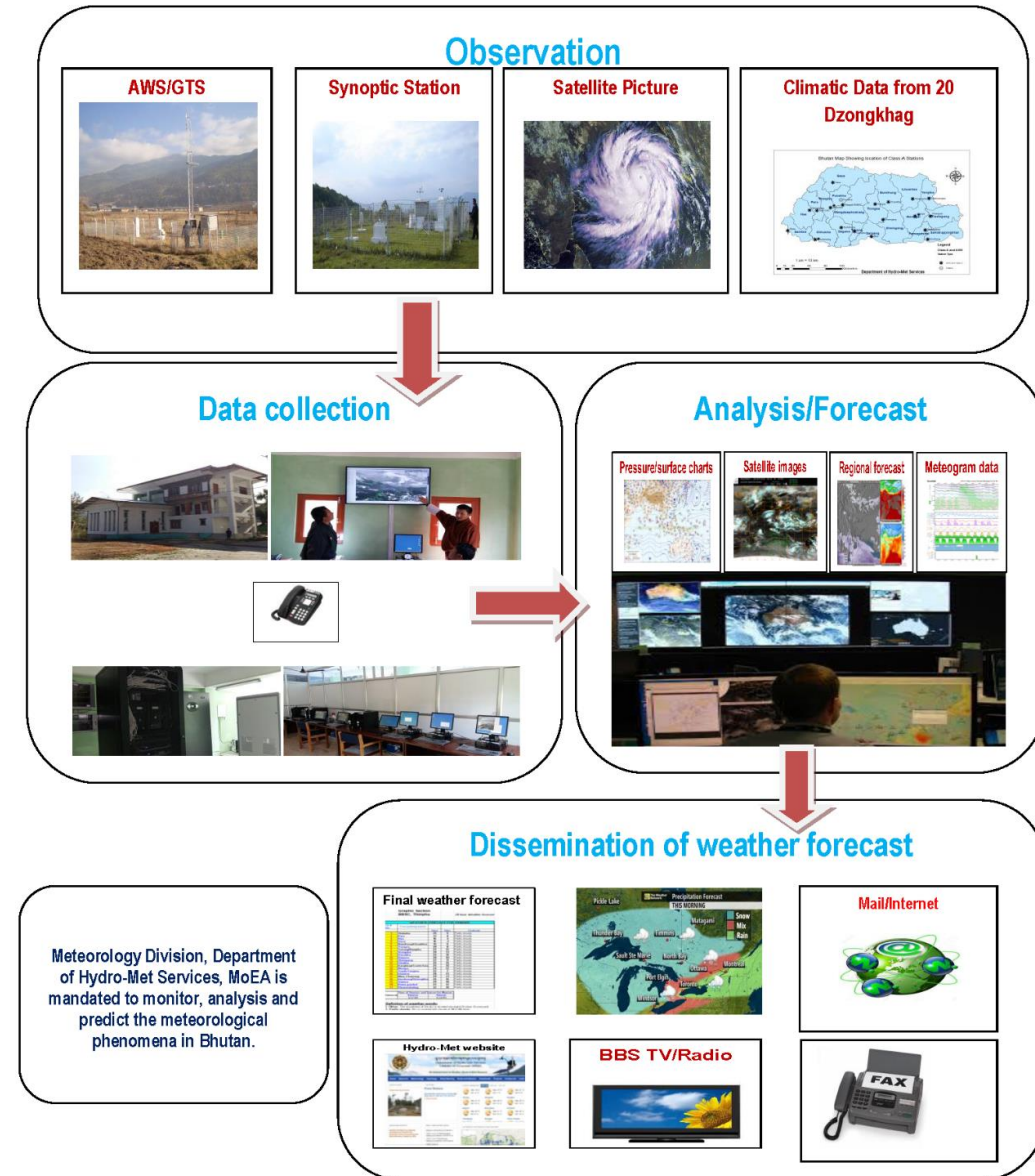
- Historical data
- Weather forecast
 - Short Range Forecast (72 hrs)
- Extended range forecast (1 month)
- Seasonal outlook (JJAS)
 - SASCOF
 - NCOF (annually)
- Climate projection (initiated)



Forecasting procedure

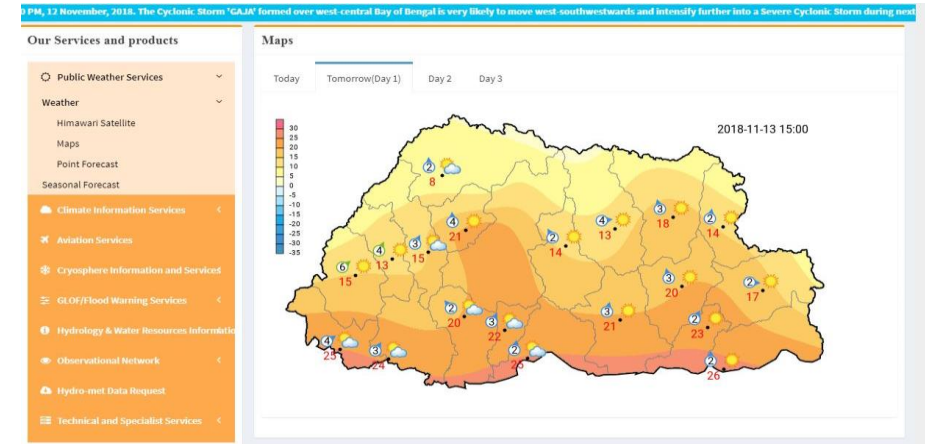
- Data collection and analysis
- Weather forecast preparation on SMARTMet system
- Forecaster refers to following;
 - Satellite image/data
 - NWP
 - Synoptic observation charts
 - Regional forecast
 - Real time weather information
- Dissemination of forecast

How are Weather Forecast made?



Forecast products

- Spatial maps of 3 days forecast (general outlook)
 - Temperature
 - Wind
 - Precipitation
- Point forecast
- Adhoc forecast services
- Extreme weather forecast



Our Services and products

- Public Weather Services
 - Weather
 - Himawari Satellite
 - Maps
 - Point Forecast
 - Seasonal Forecast
 - Climate Information Services
 - Aviation Services
 - Cryosphere Information and Services
 - GLOF/Flood Warning Services
 - Hydrology & Water Resources Information
 - Observational Network
 - Hydro-met Data Request
 - Technical and Specialist Services

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Point Forecast

Tomorrow (Day 1)

Forecasting point	Temperature deg C (24 hours)		Outlook
	Max	Min	
Thimphu	18	0	Partly cloudy
Paro	17	1	Mostly sunny
Haa	14	-2	Mostly sunny
Gasa	10	-1	Partly cloudy
Bumthang/Chamkhar	16	1	Partly cloudy
Trongsa	18	5	Partly cloudy with possibility of light rain
Tsirang/Damphu	19	9	Partly cloudy
Wangdue	26	12	Mostly sunny
Punakha	27	12	Mostly sunny
Dagana	20	8	Mostly sunny
Zhemgang	19	8	Partly cloudy
Chukha	20	7	Partly cloudy
Trashigang	22	6	Partly cloudy
Mongar	21	9	Partly cloudy
Trashigang	20	7	Partly cloudy
Lhuntse	24	10	Partly cloudy
Bhur / Sarpang	27	20	Partly cloudy
Deothang/S/Jongkhar	24	15	Partly cloudy
Samtse	27	16	Partly cloudy
Pema Gatshel	20	9	Partly cloudy
Phuentsholing	29	17	Partly cloudy



ལྷན་ཁུངས་ཚུ་དབྱེད་དང་གནམ་གཤིས་རིག་པའི་རྩེ་བ།
 National Center for Hydrology and Meteorology
 Thimphu: Bhutan



NCHM/NWFWC/FORECAST-14/2018-19/85

9 October, 2018

Rain advisory

A deep depression has formed over the central Bay of Bengal which is very likely to intensify into a tropical cyclone during the next 24 hours.

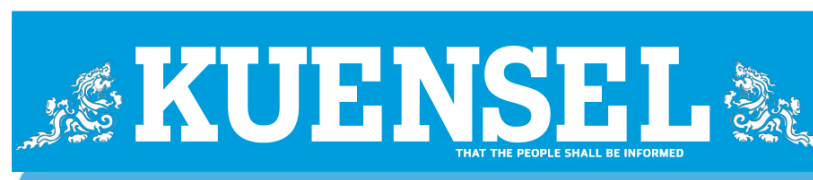
Under the influence of the system, moderate to heavy rainfall is very likely in southern and isolated places of eastern Bhutan during the next 72 hours (10th-12th October). While isolated places of central and western parts of the country is likely to receive light rainfall.

Light snowfall is also likely in high altitude areas at elevation above 4000 meters above sea level.

The system is being monitored and updates will be issued if there are significant changes in the forecast.

Please contact at 77452632/335578 for more information.

Forecast dissemination



WEATHER NOVEM
Phuentsholing

Home Notice Location About

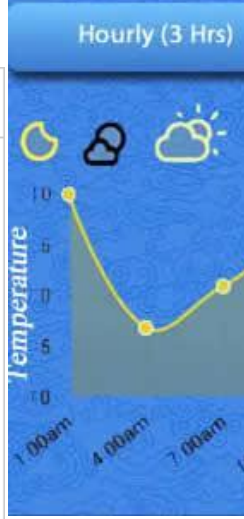
Rain: 44mm
Temp.: 27 C
Water Level: normal
Raidation: N/A
Wind Speed:

Thimphu
26/08/2016



3 DAYS FORECAST **AUG 13** AUG 14 AUG 15

Gasa Max: 25 °C Min: 14 °C	Bumthang Max: 25 °C Min: 15 °C	Trongsa Max: 24 °C Min: 15 °C
Tsirang Max: 25 °C Min: 20 °C	Wangdue Max: 32 °C Min: 20 °C	Punakha Max: 33 °C Min: 22 °C
Dagana Max: 23 °C Min: 13 °C	Zhemgang Max: 26 °C Min: 17 °C	Chhukha Max: 27 °C Min: 18 °C



Meteorology Division, Department of Hydro Met Services

WEATHER FORECASTING CENTRE
NATIONAL WEATHER AND FLOOD WARNING CENTRE (NWFV)
DEPARTMENT OF HYDRO-MET SERVICES



Facilities in NCHM for weather forecast

Observation station network

- Manual Weather Station

- Agro-met (Class A) – 20 nos



Daily measured parameter

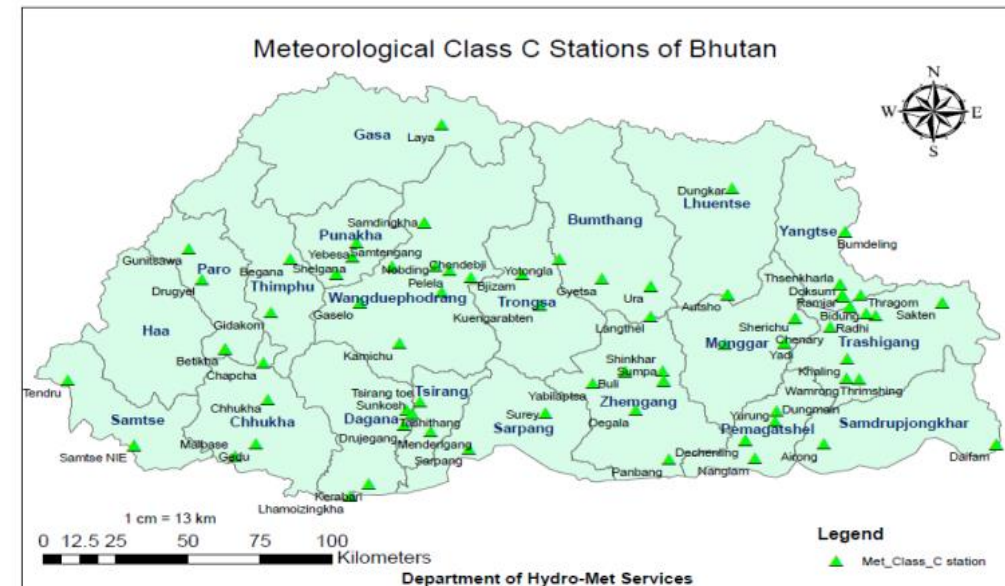
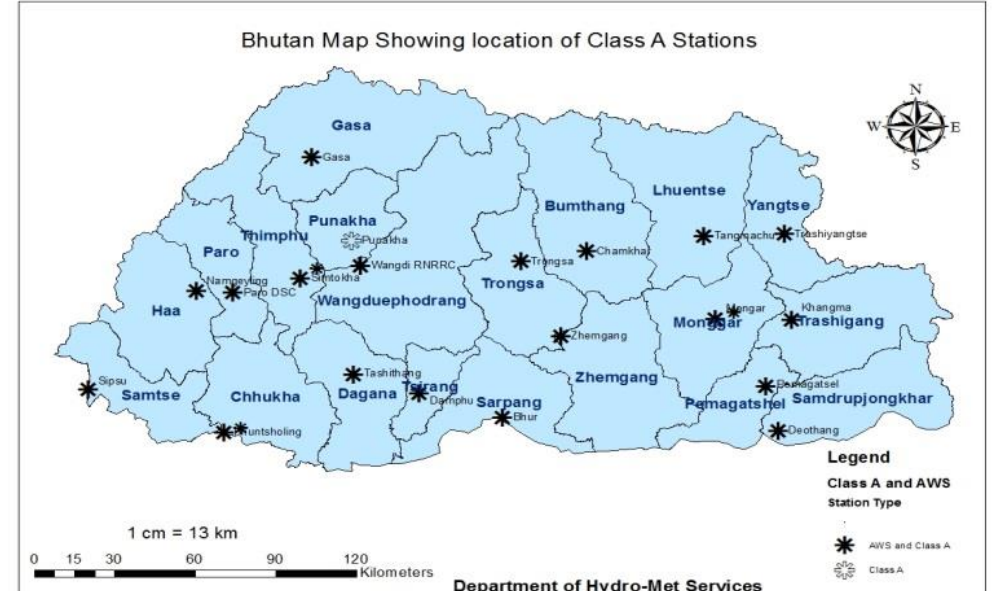
- Rainfall
- Temperature/Humidity
- Wind
- Sunshine duration
- Soil Temperature
- Evaporation

- Climatology (Class C) – 64 nos



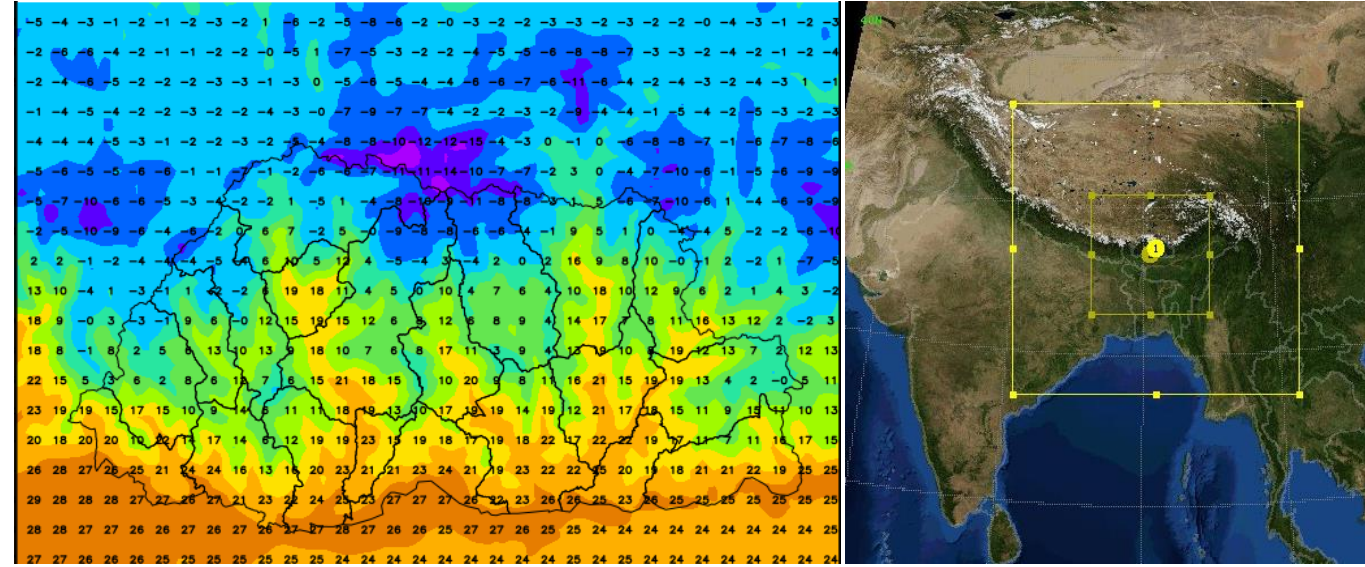
Daily measured parameter

- Rainfall
- Temperature/Humidity



- WRF Model

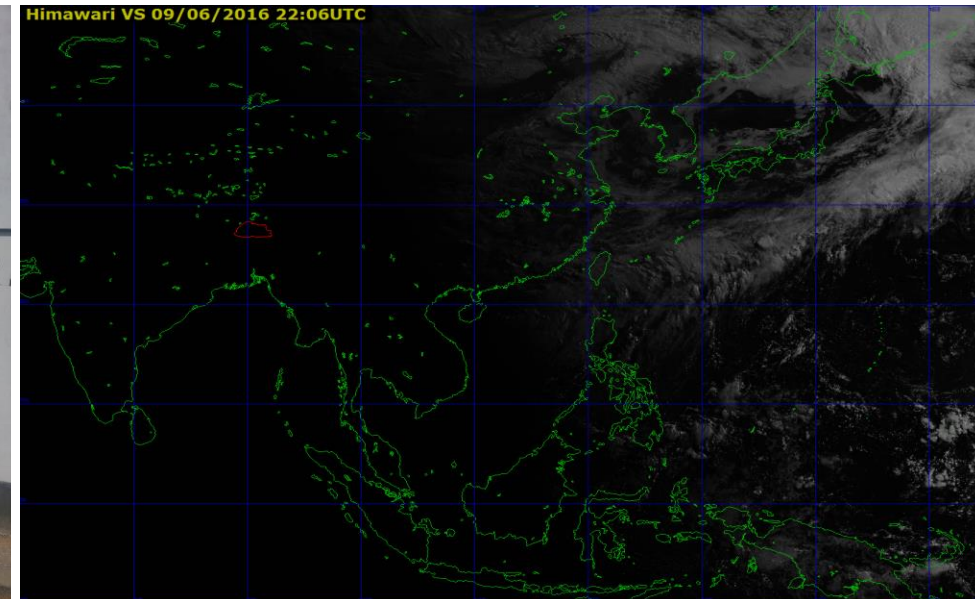
- WRF – 72 hours forecast runs
- Runs every 6 hours 00,06, 12, 18 UTC
- Initial conditions - GFS models NCEP, NOAA
- Runs for 72 hours (3 days)
- Nested domain 15 km and 3 km resolution
- Vertical=45 levels



- Satellite images – Himawari 8

- Global Telecommunication System

- SMARTMet System (Common Operating Platform) for forecast production and dissemination

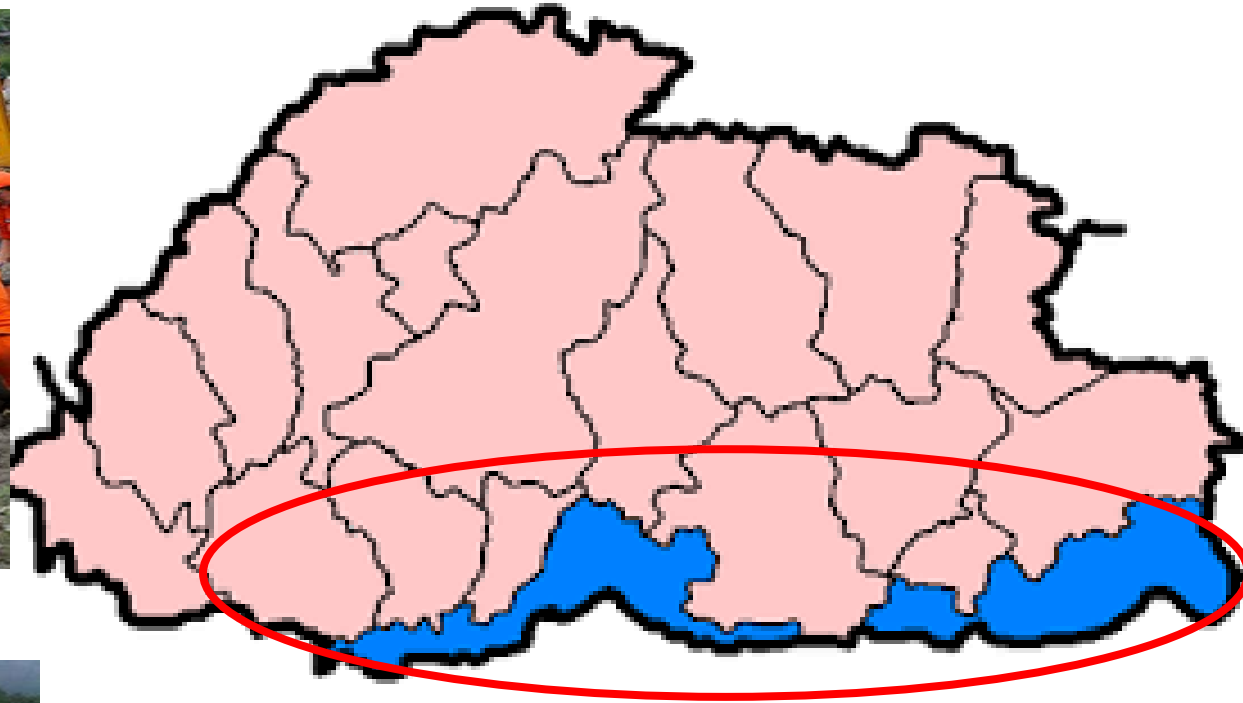


High Impact Weather: **Flash flood**



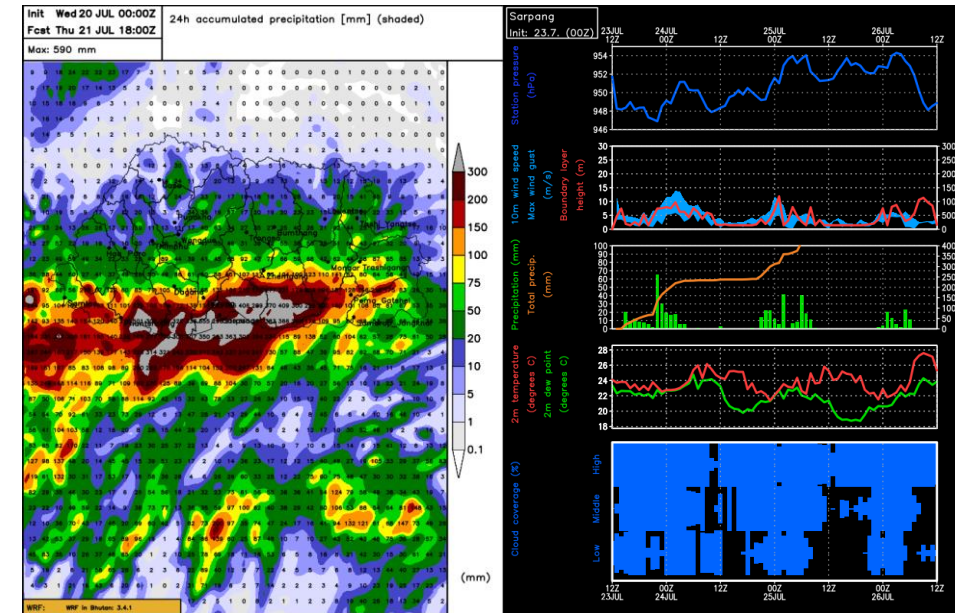
Flash flood damaged properties and agriculture field in Trashi yangtse

Sarpang Flash Flood 19-23 July 2016

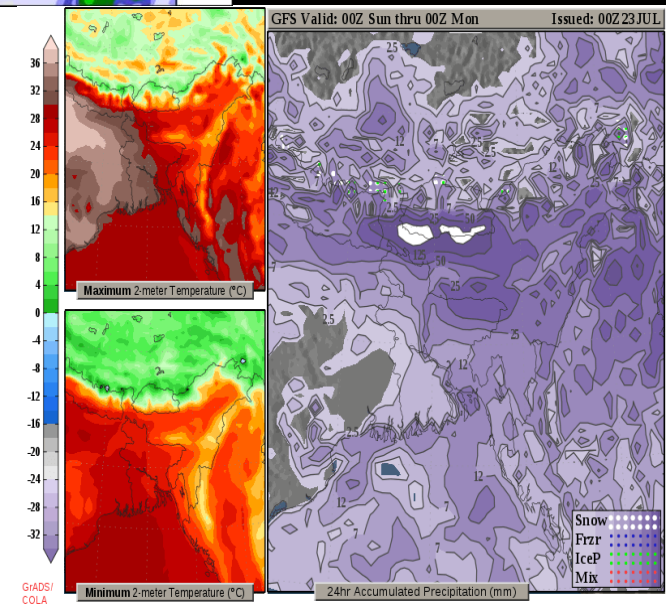


Forecast-rain in southern Bhutan

- Rain predicted by WRF model more than 200-300mm in most of southern dzongkhags from 21st July onwards.
- Heavy rainfall and more cloud is also predicted in southern; WRF model
- Rainfall trend showing increasing
- 24 to 25th July 2016 rainfall predicted well before Sarpang town flooding



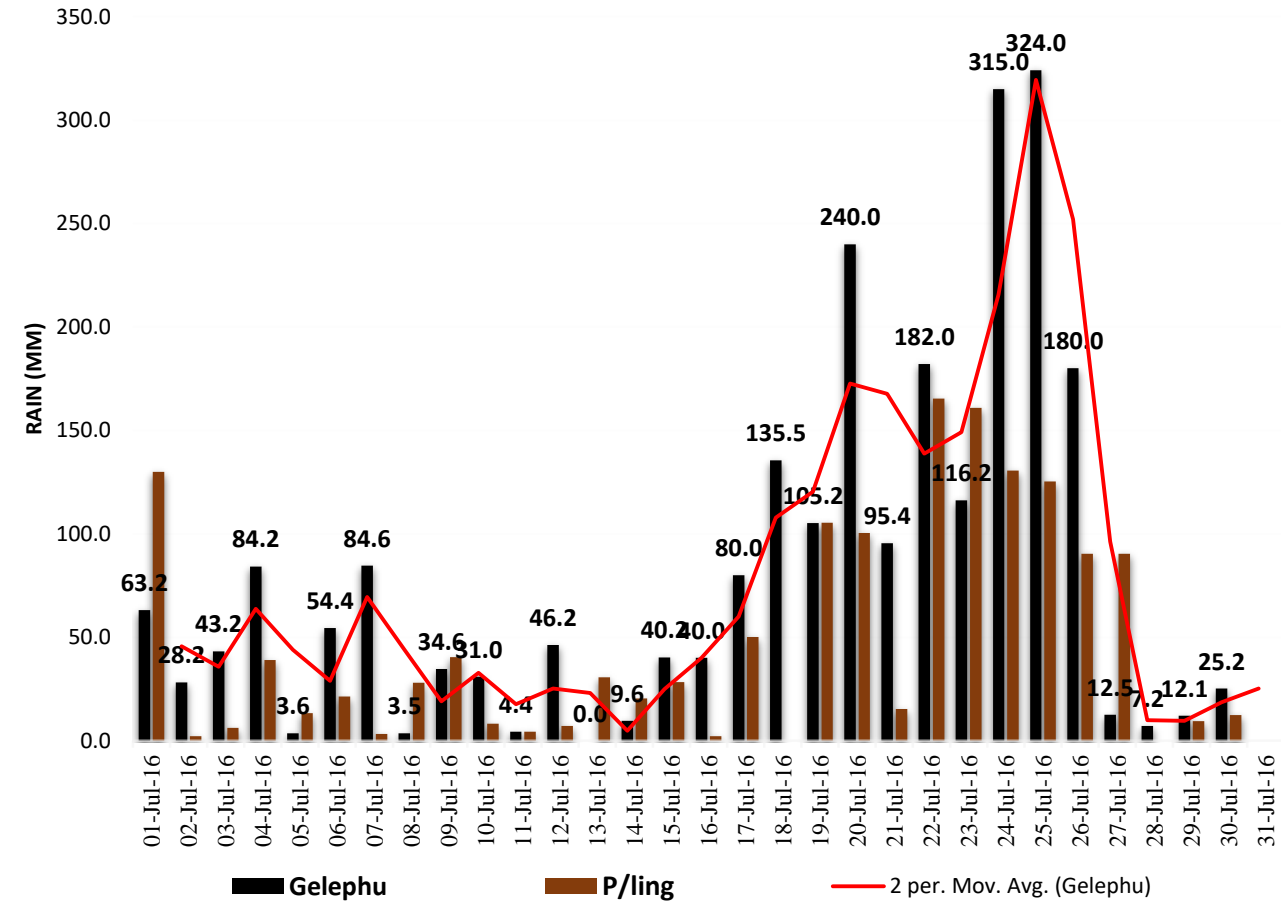
Other products shows heavy precipitation over southern Bhutan



Daily rainfall (Bhur and P/Ling: July 2016)

July 2016 Rain: Gelephu and P/Ling

The intensity of rainfall also showing increasing from dated 18 (**135.5 mm**) onwards (**315.00 mm-24/07/2016** and **324.00 mm-25/07/2016**).



Findings

1. All models predicted heavy rain before flooding of Sarpang town.
2. Himawari-8 and Kalpana Satellites images also showing more dense cloud coverage for few days in southern dzongkhags during before-flooding.
3. The intensity of rainfall also showing increasing from dated 18 **(135.5 mm)** onwards **(315.00 mm- 24/07/2016 and 324.00 mm- 25/07/2016)**.
4. Weather warning had issued in timely (HM, PMO, Ministers, Disaster management, BBSC, Radio section, print media and others.

Sarpang town after flash flood



Wind storm and hail stone

- Wind storm is second most meteorological event that impacts crops and infrastructural in Bhutan besides flood.
- Hailstone damages- **Pre monsoon and post monsoon.**
- Thunderstorm
- Heavy snowfall

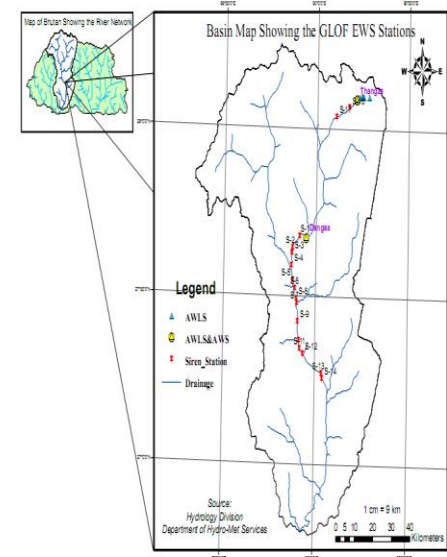
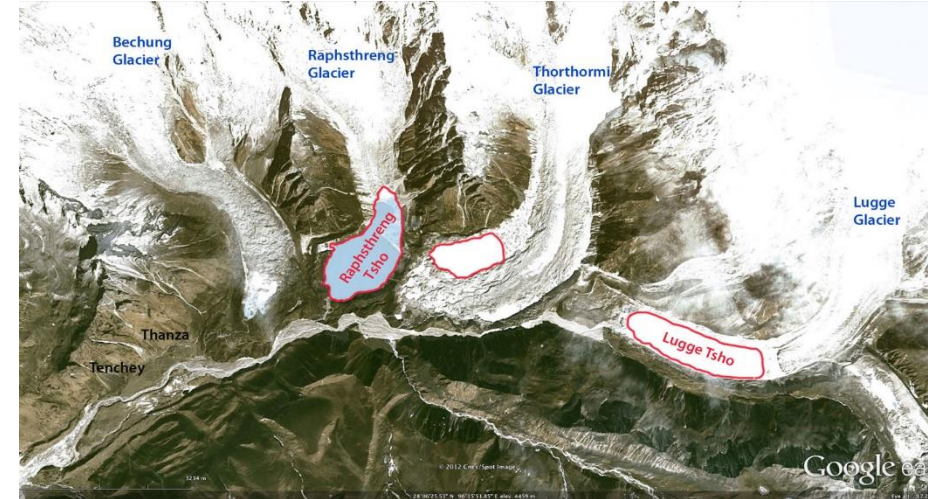


Current Alert Systems (GLOF and rainstorm **EWS in Bhutan**)

Early Warning System

Existing • GLOF EWS Punatshangchu Basin

- 10 AWLS and AWS
- 18 Sirens
- Communication
- Iridium Satellite
- All Siren stations are placed high above the population centers for maximum sound projection.
- Sirens can be activated from Control Room automatically and manually
- 24/7 control room monitoring



Weather warning communication

1. NCHM → Disaster Management → 20 dzongkhags → local level

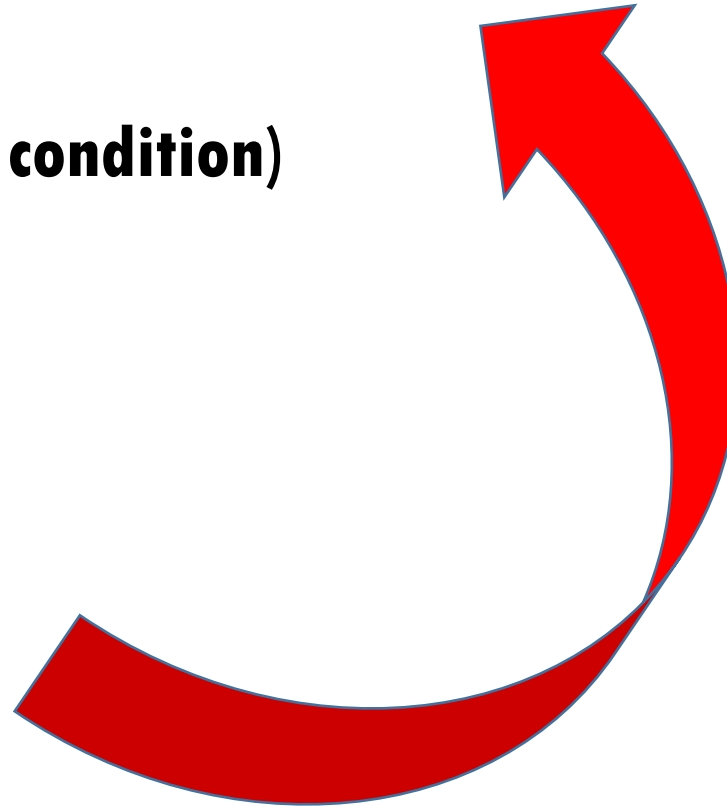
2. NCHM → Media/TV (Normal condition)
→ PMO and others

3. Extreme: Discuss (Forecasters)

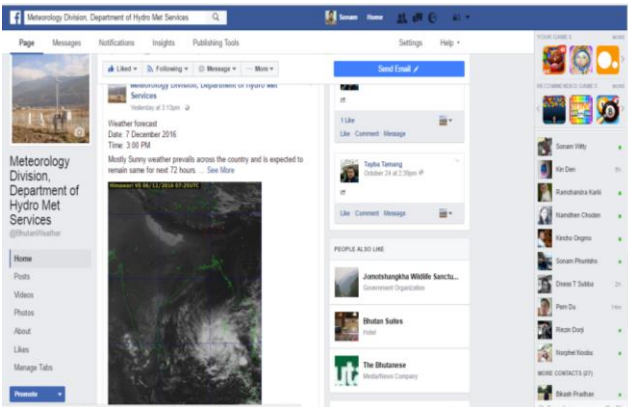
Forecasting Head

Chief WCSD

Director/Action



Extreme weather warnings



Press release of Cyclone storm "KOMAN" - 31st July 2015 4.00 PM

According to forecast from the Department of Hydro-Met Services, Ministry of Economic Affairs, a cyclonic storm "KOMEN" was developed on 30 July over northeast Bay of Bengal. The cyclonic storm Komen has now weakened into Deep Depression over the Chittagong, Bangladesh. The deep depression would move west-northwestwards and weaken gradually into depression and then into low pressure. There is no direct impact from this system on Bhutan however heavy rain is expected in most parts of the southern and eastern Bhutan during next 48 hours due to the peripheral effect of the depression. Rest of the country will be mostly cloudy with moderate rain during next 48 hours.

Weather is expected to improve from Monday. Updates on weather will be provided if there is any change in the system.

Department of Hydro Met Services
Ministry of Economic Affairs.



We issue extreme weather warning through different mode of communication such as Facebook, website, mobile and press release to different media houses (Print media, radio and television).

Inter- governmental strategy: Reduce damages

Weather Services

- 12-72 hrs weather forecast
- Advisories/bulletins/warnings of extreme weather events
- Customized Services-Location specific forecast
- **Extended Range Prediction (10-30 days)**

Climate Services

- Seasonal climate information
- Provision historical climate data (hard/soft copy)
- Annual climate reports/monthly climate reports
- **Climate Change Projection**

Education and Awareness Program

- Trainings and workshops



Conclusion

- NCHM provides weather and climate services, there is need for Impact based forecast
- Weather forecast of 72 hrs is issued
- Extreme weather warning - Press release through different media
- Capacity building required for implementing Impact Based Forecast.

THANK YOU.....



To be interested in the changing seasons is a happier state of mind than to be hopelessly in love with spring. ~ George Santayana